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KING EIDER *(Somateria spectabilis)* MATED WITH COMMON EIDER *(S. mollissima)*

A male King Eider stationed near his mate, an incubating female Common Eider; photographed by Olin Sewall Pettingill, Jr., on May 26, 1958, in Northwest Iceland.

KING EIDERS MATED WITH COMMON EIDERS IN ICELAND

BY OLIN SEWALL PETTINGILL, JR.

THE Common Eider (*Somateria mollissima*) is one of Iceland's most abundant birds, with an estimated breeding population of a half million individuals (see Pettingill, 1959). The majority nest in colonies whose sizes range from a few pairs to many hundreds. From May 24 to 27, 1958, it was my good fortune to study and film one of the largest colonies (5,000 nests), situated on the farm of Gisli Vagnsson, along the Dyrafjördur in Northwest Iceland. Egg-laying at this time was virtually completed, with incubation just getting under way.

In my earlier paper (*op. cit.*) I have described the colony and pointed out that the males were present, each one stationed close to a nest while his mate sat on it. Many nests were near together—in a few cases as close as two feet, with the result that there was marked hostility among the guarding males. Presumably the males departed from the colony after the first ten days of incubation as they did on the Inner Farne (Tinbergen, 1958), an island off the northeast coast of England.

Before I visited the Vagnsson colony, Dr. Finnur Gudmundsson, Curator in the Natural History Museum at Reykjavik, told me that I should expect to find from one to several male King Eiders (*S. spectabilis*) mated with female Common Eiders. He had noted many mixed pairs himself in various Iceland colonies and once published an account of his observations (Gudmundsson, 1932:96–97). He went on to say that such matings are of "frequent occurrence" in Iceland and have been known about since the 18th Century. Farmers formerly regarded a male King Eider in a colony as an aberrant male Common Eider with the status of "king." Interestingly, Dr. Gudmundsson had never seen a male Common Eider paired with a female King Eider and had no authoritative report of any such instance.

The presence of these peculiarly mixed pairs in Iceland is remarkable as the island lies outside the breeding range of the King Eider. There is no substantiated evidence of a pure *spectabilis* pair ever having bred in Iceland. The species does, however, visit the coast of Iceland regularly in the winter, though never in large numbers. Practically all records refer to single birds, mostly adult males, in company with Common Eiders. It is not impossible, of course, that a few female and immature male King Eiders also occur in winter, but, owing to the similarity of their respective plumages to those of female and immature male Common Eiders, they are overlooked.

For the phenomenon of mixed pairs in Iceland, Dr. Gudmundsson has the following explanation: If, toward the end of winter, a visiting male King Eider pairs with a female Common Eider from Iceland, the male thereafter

accompanies the female, eventually following her to the nesting colony and remaining with her. On the other hand, if a male Common Eider from Iceland pairs with a female King Eider, say, from Greenland, the male follows her to Greenland. The basis of Dr. Gudmundsson's explanation is that, after pair formation, the male follows the female to her point of origin, wherever it may be. Considerable strength is given this assumption by Hochbaum's generalized statement (1944:62) that among ducks in the Delta Marsh (Manitoba, Canada) it is the initiative of the female that leads the pair to the breeding area.

Dr. Gudmundsson's prediction that I should find mixed pairs in the Vagnsson colony was borne out soon after my arrival for I discovered altogether two male King Eiders in normal, fully adult plumage. Each sat close to an incubating female, obviously a normal Common Eider, in a different part of the colony. Their nests were closely surrounded by other nests belonging to pure pairs of Common Eiders. The presence of the King Eiders was "an old story" to Gisli Vagnsson. The colony had been in existence since 1912, and for as long as he could remember there had always been at least one *kongur* every nesting season.

On watching the two King Eiders for short periods during the course of my visit, I became impressed with the similarity of their behavior to the behavior of neighboring male Common Eiders. Both Kings showed aggression, as did the male Commons, making vigorous attacks on near-by males, and occasionally grasping an opponent by the head, neck, wings, or tail. Both Kings were themselves attacked and grasped. A lively fight between a King and a Common sometimes took place, during which both contestants bit and thrashed each other, but neither one emerged the worse for the encounter. I could see only one difference in the behavior of the two Kings. One seemed far more aggressive by attacking several male Commons in succession at points as far away from the nest as 10 to 15 feet. I judged this behavior to be the result of his greater intolerance of adjacent males.

The fact that the two King Eiders adjusted themselves to the colony is notable since the species does not nest in colonies on its home grounds. In Greenland, for instance, the King Eider never gathers in colonies (Salomonsen, 1950–51:132–133). A natural expectation would be that a species without adaptation to colonial life could not tolerate the competition or crowding imposed by the proximity of so many nesting pairs.

Despite the frequency of mixed pairs in Iceland over a period of many years, even centuries, no *spectabilis* characters are discernible in the present population of Common Eiders. All the males which I saw in the Vagnsson colony and elsewhere were apparently pure *mollissima*. Only one hybrid specimen is known to have been taken in the country. This is a male (now in the Museum of Natural History) shot in the bay just outside Reykjavik about

1929. Further data are unavailable because it was recovered as a mounted bird in a school collection where it had been for several years. The specimen shows a blending of the characters of both species, though the *spectabilis* characters are more conspicuous. Two *mollissima* × *spectabilis* hybrids were taken in Greenland in 1894 and 1906, respectively, and later described by Krabbe (1926). Like the Iceland specimen, they too showed a blending of characters of both species. To the best of my knowledge, no other hybrid of these two species has ever been taken anywhere.

On the basis of the evidence at hand I can only conclude that offspring of mixed pairs of Common and King Eiders are rarely produced, and that in all probability the few hybrids which do result are sterile.

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FORTY YEARS OF SPRING MIGRATION IN SOUTHERN CONNECTICUT

BY ARETAS A. SAUNDERS

For many years it has been my habit to rise early on spring mornings, and spend the early hours keeping track of the bird migration. In earlier years this was in the vicinity of New Haven, Connecticut. Later it was in Norwalk, and finally in Fairfield. All of these are about the same latitude along the coast. Observations first began in 1902 but are rather incomplete in the earlier years. From 1908 to 1913 I was elsewhere, but from 1914 to 1949 the records are quite complete.

I will not assert that I always found each species on the day its first individuals arrived. I know that in some cases I did not, for others informed me, at times, that they had found certain species a day or two before I did. I have used some of these earlier dates whenever I was sure that they were reliable. For example, Mr. Frank Novak, warden of the Birdcraft Sanctuary in Fairfield, frequently found the first House Wren a day or two before I did.

In finding birds I frequently used my knowledge of bird songs. It is much easier to hear a bird sing, and identify it by the song than it is to get a clear view of it in just the right light to identify it. I do not mean, however, that I relied on song in all cases. The Veery, for example, usually arrives several days before it begins to sing. If a song was unrecognizable, or that of a rare species, I made it a practice to see the bird.

In general, when a species arrives its numbers begin to increase, and it is soon common. Occasionally a single individual arrives long before the rest of its species. I found this true on two occasions with the White-eyed Vireo, and once with the Indigo Bunting. In each case it was many days before another individual appeared. Both are birds that arrive in May, and in each case the early individuals arrived in April.

My data on the arrivals of shore and water birds are not as complete, largely because such birds were scarce in the earlier days. When the Migratory Bird Treaty Act (1916) was put into effect, and the shore birds were all protected, the increase in these species was remarkable. The case of the Laughing Gull illustrates this. When a species is common, its migration dates are likely to be earlier than when it is scarce. This gull was very rare when "The Birds of Connecticut" (Sage and Bishop, 1913) was published. I saw my first one in 1916. By 1919 I began recording its arrival in spring migration. For the first 11 years thereafter its date of arrival averaged between May 6 and 7. For the entire period, 1919 to 1949, it averaged about April 26. But for the last 16 years the average was between April 16 and 17. These last years are probably more nearly the correct time.

The two species of orioles also indicate the extent to which the abundance of a species produces earlier dates. The Baltimore Oriole is exceedingly common, but the Orchard Oriole rather uncommon. In certain years I have found both species arriving on the same day, but the average arrival of the Baltimore Oriole is about May 5, whereas that of the Orchard Oriole is between May 9 and 10.

I have listed in Tables 1–3 all of the species that I am including in this paper. They are divided into lists of arrivals of summer residents; departures of winter visitors; and arrivals and departures of transient species. In each case the earliest, latest and average dates are given. This does not include all of the birds observed through the period, for there are resident species that do not migrate, and many species too rare to give definite dates on migration.

One of the interesting things about this study is the difference between different years, some being early, others late, and still others about average. In order to study these years and compare them I have selected 50 common summer resident species and arranged them in order of their average dates of arrival, from the Common Grackle in early March, to the Yellow-billed Cuckoo in the latter part of May (Table 4).

When one has a series of dates of arrival of any given species and adds them up and determines the average date of arrival, that date is likely to be a fraction. It would be incongruous to speak of the average date of arrival of the Yellow Warbler, for example, as May 1.52. All averages were calculated to two decimal places, however, to determine the order of listing of species (Table 4), especially of those whose average arrivals were on the same day. However, each fractional amount was "rounded-off" to the nearest date for Tables 1–4.

There is not a species whose average arrival is in March, that has not been known to occur, sometimes, in the winter. There is usually, however, some means of indicating the difference between migrating birds and wintering ones. Wintering birds generally occur in certain localities, but migrating ones are likely to be in new places. It is because of the lack of anything definite to distinguish winter birds from migrants that I left the Song Sparrow out of Table 4. Numbers of the birds spend the winter, but they are likely to sing in January or February, before migration begins; and while there are indications of migration early in March, I did not feel too sure of the dates.

From the data on average arrivals I have constructed diagrams, plotting the species horizontally, and the dates of arrivals vertically, the earlier dates at the bottom. Thus, the 50 species make a line that gradually rises from left to right.

Then, plotting the actual dates of arrival for any one year forms a very irregular line. Early dates come below the line of average arrivals, and late dates above it. I have thus made diagrams for all of the years for which I have

records, and I am using four of these as illustrations (Figs. 1–4). The four selected are 1938, 1940, 1917 and 1923. 1938 (Fig. 1) is the year of earliest arrivals in my records. 1940 (Fig. 2) is the most uniformly late year. 1917 (Fig. 3) is an unusual year, actually latest in total figures, but not uniformly so, and 1923 (Fig. 4) is nearest the calculated average.

For each year I determined the number of days and fractions of days that each species was early or late, added the late dates and the early dates, subtracted the smaller result from the larger, which determined whether the year was early or late, and divided the result by 50, which gave me the average number of days or fractions of a day that the species were early or late.

By this means I determined that the 50 species averaged 6.15 days early in 1938 and 3.55 days late in 1940. In 1923 they were 0.20 days early, and in the erratic year of 1917 they averaged 5.38 days late.

The year 1917 was a most remarkable one. In March and April the first 19 species of the 50 summer residents averaged a little less than 1 day late, but the remaining 31 species that had average arrivals in May were 7.98 days late. The weather in the early days of May was cold, raw and more or less rainy. I searched for birds at a time when one normally expects them to be arriving in numbers. On May 3 I found one American Redstart, but not another till May 15. On May 5 there was one Catbird and one Ovenbird. A Bobolink appeared on May 9, and a Veery on May 10. Then, on May 12, birds began appearing in numbers. From then until the 19th birds were everywhere. They were mostly warblers and thrushes and were down low in the shrubbery but were easily seen. Transient species were even later than the summer residents. Ruby-crowned Kinglets were present till May 18. Parula, Magnolia, Blackburnian and Bay-breasted Warblers remained till June 2, Tennessee Warblers till June 9, and Blackpoll Warblers to June 10. I have previously published something about the relation of these birds to tent caterpillars in this particular spring (1920. *Auk*, 37:312).

In the springs of 1923 and 1924 the arrival dates came close to the average. Actually, 1924 figured closer to the average, but the figures, species by species, were more erratic than 1923.

I hoped that the figures obtained would give some data on cycles of early and late years. While they did not show anything very definite, they did show that there were more late years in the early part of the period, and early years in the latter part. In the period from 1902 to 1934, the years for which I have records averaged 0.99 days late. From 1935 to 1949, the years averaged 1.48 days early. There were 15 late years and seven early ones in the first period, and three late ones and 12 early ones in the second period.

I thought that there might be some correlation between bird migrations and the growth of trees. I knew of only one tree that had been cut at a date that

was definite. A large white oak, that I had passed by many times, was cut down in the fall of 1956. When I examined its stump the outer rings were so small that I needed a lens to count them. There was one ring definitely wider than the others, and counting back from the outermost ring that ring proved to be 1938. But in the rings earlier than that I could find nothing definite.

TABLE 1

ARRIVALS OF SUMMER RESIDENTS

Species	No. of Years	Average	Earliest	Latest
Green Heron (*Butorides virescens*)	34	Apr. 27	Apr. 15, 1920	May 8, 1931
Black-crowned Night Heron (*Nycticorax nycticorax*)	34	Apr. 10	Mar. 25, 1945	Apr. 24, 1935
Wood Duck (*Aix sponsa*)	14	Mar. 25	Feb. 28, 1946	Apr. 25, 1925
Broad-winged Hawk (*Buteo platypterus*)	15	May 1	Apr. 17, 1925	May 16, 1947
Clapper Rail (*Rallus longirostris*)	19	May 15	May 2, 1930	May 28, 1922
Killdeer (*Charadrius vociferus*)	34	Mar. 23	Mar. 13, 1938	Apr. 3, 1940
Spotted Sandpiper (*Actitis macularia*)	40	May 2	Apr. 25, 1916	May 14, 1924
Mourning Dove (*Zenaidura macroura*)	30	Mar. 18	Feb. 19, 1944	Apr. 6, 1924
Yellow-billed Cuckoo (*Coccyzus americanus*)	28	May 18	May 7, 1949	June 1, 1920
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	30	May 13	May 1, 1928	May 31, 1921
Whip-poor-will (*Caprimulgus vociferus*)	10	Apr. 28	Apr. 22, 1914	May 6, 1931
Common Nighthawk (*Chordeiles minor*)	33	May 15	May 5, 1919	May 27, 1927
Chimney Swift (*Chaetura pelagica*)	39	Apr. 28	Apr. 12, 1947	May 6, 1931
Ruby-throated Hummingbird (*Archilochus colubris*)	29	May 15	May 3, 1938	May 26, 1929
Belted Kingfisher (*Megaceryle alcyon*)	34	Mar. 23	Mar. 13, 1938	Apr. 3, 1940
Yellow-shafted Flicker (*Colaptes auratus*)	37	Mar. 25	Mar. 12, 1919	Apr. 7, 1940
Eastern Kingbird (*Tyrannus tyrannus*)	40	May 7	Apr. 30, 1940	May 18, 1917
Great Crested Flycatcher (*Myiarchus crinitus*)	35	May 9	Apr. 30, 1933	May 22, 1931
Eastern Phoebe (*Sayornis phoebe*)	40	Mar. 24	Mar. 12, 1921	Apr. 8, 1946
Least Flycatcher (*Empidonax minimus*)	35	May 2	Apr. 27, 1915	May 12, 1917
Eastern Wood Pewee (*Contopus virens*)	39	May 18	May 12, 1937	June 2, 1906
Rough-winged Swallow (*Stelgidopteryx ruficollis*)	30	Apr. 22	Apr. 3, 1938	May 10, 1917
Barn Swallow (*Hirundo rustica*)	40	Apr. 18	Apr. 3, 1938	Apr. 28, 1945
Purple Martin (*Progne subis*)	13	Apr. 28	Apr. 3, 1938	May 5, 1932
Fish Crow (*Corvus ossifragus*)	36	Mar. 26	Mar. 5, 1921	Apr. 9, 1940
House Wren (*Troglodytes aedon*)	39	Apr. 25	Apr. 16, 1922	May 4, 1940
Long-billed Marsh Wren (*Telmatodytes palustris*)	21	May 18	Apr. 30, 1941	May 26, 1945
Catbird (*Dumetella carolinensis*)	40	May 2	Apr. 25, 1921	May 6, 1931

TABLE 1 (Continued)

Species	No. of Years	Average	Earliest	Latest
Brown Thrasher (*Toxostoma rufum*)	40	Apr. 22	Apr. 7, 1929	May 4, 1940
Robin (*Turdus migratorius*)	40	Mar. 10	Feb. 20, 1946	Mar. 22, 1926
Wood Thrush (*Hylocichla mustelina*)	40	May 2	Apr. 27, 1939	May 13, 1917
Veery (*Hylocichla fuscescens*)	40	May 6	Apr. 30, 1933	May 15, 1920
Eastern Bluebird (*Sialia sialis*)	40	Mar. 9	Feb. 22, 1939	Mar. 23, 1928
White-eyed Vireo (*Vireo griseus*)	35	May 7	Apr. 23, 1938	May 19, 1917
Yellow-throated Vireo (*Vireo flavifrons*)	35	May 6	Apr. 30, 1938	May 17, 1917
Red-eyed Vireo (*Vireo olivaceus*)	40	May 11	May 2, 1906	May 19, 1917
Warbling Vireo (*Vireo gilvus*)	35	May 9	May 1, 1938	May 22, 1948
Black-and-white Warbler (*Mniotilta varia*)	36	Apr. 25	Apr. 18, 1936	Apr. 30, 1922
Worm-eating Warbler (*Helmitheros vermivorus*)	33	May 12	May 4, 1944	May 22, 1948
Blue-winged Warbler (*Vermivora pinus*)	40	May 4	Apr. 28, 1945	May 13, 1917
Yellow Warbler (*Dendroica petechia*)	40	May 2	Apr. 26, 1929	May 15, 1917
Black-throated Green Warbler (*Dendroica virens*)	38	Apr. 30	Apr. 24, 1922	May 11, 1917
Chestnut-sided Warbler (*Dendroica pensylvanica*)	39	May 5	Apr. 28, 1938	May 17, 1917
Prairie Warbler (*Dendroica discolor*)	38	May 4	Apr. 27, 1938	May 18, 1917
Ovenbird (*Seiurus aurocapillus*)	40	May 2	Apr. 27, 1945	May 7, 1920
Louisiana Waterthrush (*Seiurus motacilla*)	35	Apr. 18	Apr. 6, 1928	Apr. 25, 1924
Yellowthroat (*Geothlypis trichas*)	38	May 4	Apr. 28, 1938	May 16, 1937
Yellow-breasted Chat (*Icteria virens*)	37	May 9	May 3, 1929	May 18, 1917
Hooded Warbler (*Wilsonia citrina*)	32	May 8	May 1, 1938	May 22, 1948
American Redstart (*Setophaga ruticilla*)	38	May 3	Apr. 30, 1938	May 15, 1948
Bobolink (*Dolichonyx oryzivorus*)	31	May 6	Apr. 28, 1935	May 10, 1925
Eastern Meadowlark (*Sturnella magna*)	37	Mar. 21	Mar. 9, 1922	Mar. 31, 1940
Redwinged Blackbird (*Agelaius phoeniceus*)	40	Mar. 9	Feb. 19, 1939	Mar. 25, 1920
Orchard Oriole (*Icterus spurius*)	35	May 10	Apr. 30, 1938	May 22, 1947
Baltimore Oriole (*Icterus galbula*)	40	May 5	Apr. 30, 1938	May 12, 1917
Common Grackle (*Quiscalus quiscula*)	40	Mar. 8	Feb. 24, 1925	Mar. 26, 1916
Brown-headed Cowbird (*Molothrus ater*)	40	Mar. 26	Mar. 13, 1946	Apr. 7, 1947
Scarlet Tanager (*Piranga olivacea*)	40	May 8	Apr. 30, 1938	May 19, 1917
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	40	May 5	Apr. 30, 1935	May 15, 1917
Indigo Bunting (*Passerina cyanea*)	39	May 15	Apr. 22, 1941	May 23, 1917
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	40	Apr. 19	Apr. 8, 1915	Apr. 29, 1937
Grasshopper Sparrow (*Ammodramus savannarum*)	27	May 4	Apr. 28, 1925	May 16, 1931
Henslow's Sparrow (*Passerherbulus henslowii*)	7	May 5	Apr. 28, 1941	May 9, 1936

TABLE 1 (Continued)

Species	No. of Years	Average	Earliest	Latest
Sharp-tailed Sparrow (*Ammospiza caudacuta*)	30	May 20	May 8, 1938	May 29, 1930
Seaside Sparrow (*Ammospiza maritima*)	31	May 17	May 4, 1938	May 30, 1931
Vesper Sparrow (*Pooecetes gramineus*)	40	Apr. 1	Mar. 15, 1920	Apr. 15, 1940
Chipping Sparrow (*Spizella passerina*)	38	Apr. 13	Apr. 1, 1945	Apr. 21, 1932
Field Sparrow (*Spizella pusilla*)	39	Mar. 27	Mar. 16, 1929	Apr. 6, 1934
Song Sparrow (*Melospiza melodia*)	36	Mar. 6	Feb. 25, 1930	Mar. 17, 1934

TABLE 2

DEPARTURES OF WINTER VISITORS

Species	No. of Years	Average	Earliest	Latest
Horned Grebe (*Podiceps auritus*)	20	Apr. 24	Apr. 15, 1924	May 15, 1933
Greater Scaup (*Aythya marila*)	23	Apr. 18	Mar. 30, 1935	May 12, 1917
Common Goldeneye (*Bucephala clangula*)	33	Apr. 9	Mar. 12, 1927	May 18, 1940
Bufflehead (*Bucephala albeola*)	21	Apr. 19	Mar. 10, 1928	May 12, 1917
Oldsquaw (*Clangula hyemalis*)	32	May 11	Apr. 17, 1918	May 30, 1941
White-winged Scoter (*Melanitta deglandi*)	27	May 18	Apr. 5, 1924	June 1, 1936
Surf Scoter (*Melanitta perspicillata*)	17	Apr. 29	Apr. 10, 1937	May 26, 1922
Common Merganser (*Mergus merganser*)	21	Apr. 10	Apr. 2, 1921	May 3, 1947
Red-breasted Merganser (*Mergus serrator*)	22	May 11	Apr. 15, 1928	May 13, 1919
Purple Sandpiper (*Erolia maritima*)	6	May 9	Apr. 3, 1938	June 5, 1943
Great Black-backed Gull (*Larus marinus*)	18	Apr. 13	Mar. 18, 1931	May 4, 1947
Horned Lark (*Eremophila alpestris*)	14	Mar. 19	Feb. 27, 1943	Apr. 8, 1939
Red-breasted Nuthatch (*Sitta canadensis*)	9	Apr. 14	Mar. 25, 1949	May 7, 1932
Brown Creeper (*Certhia familiaris*)	28	Apr. 22	Apr. 6, 1929	May 19, 1917
Golden-crowned Kinglet (*Regulus satrapa*)	22	Apr. 23	Apr. 3, 1921	May 16, 1917
Myrtle Warbler (*Dendroica coronata*)	35	May 18	May 7, 1918	May 28, 1927
Slate-colored Junco (*Junco hyemalis*)	40	Apr. 29	Apr. 19, 1915	May 17, 1917
Tree Sparrow (*Spizella arborea*)	37	Apr. 2	Mar. 12, 1918	Apr. 25, 1940
Snow Bunting (*Plectrophenax nivalis*)	13	Feb. 25	Feb. 12, 1937	Mar. 10, 1934

TABLE 3

ARRIVALS AND DEPARTURES OF TRANSIENTS

Species	No. of Years	Arrivals			Departures		
		Average	Earliest	Latest	Average	Earliest	Latest
Common Loon (*Gavia immer*)	27	Apr. 13	Mar. 28, 1936	Apr. 28, 1936	May 24	May 1, 1929	June 20, 1942
Pied-billed Grebe (*Podilymbus podiceps*)	13	Apr. 3	Mar. 20, 1934	Apr. 19, 1917	Apr. 28	Apr. 15, 1940	May 12, 1928
Great Blue Heron (*Ardea herodias*)	25	Apr. 7	Mar. 12, 1949	Apr. 17, 1927	May 19	May 4, 1944	May 31, 1942
Canada Goose (*Branta canadensis*)	12	Mar. 31	Mar. 7, 1946	Apr. 17, 1918	May 13	May 1, 1941	June 5, 1938
Ring-necked Duck (*Aythya collaris*)	12	Mar. 16	Mar. 1, 1938	Apr. 3, 1942	Apr. 26	Apr. 11, 1942	May 3, 1939
Osprey (*Pandion haliaetus*)	27	Apr. 11	Mar. 25, 1944	Apr. 26, 1922	May 10	Apr. 30, 1938	May 28, 1927
Semipalmated Plover (*Charadrius semipalmatus*)	32	May 13	May 3, 1924	May 29, 1920	June 3	May 28, 1921	June 14, 1939
Black-bellied Plover (*Squatarola squatarola*)	25	May 15	Apr. 28, 1946	May 24, 1930	June 5	May 28, 1922	June 17, 1939
Ruddy Turnstone (*Arenaria interpres*)	33	May 21	May 8, 1938	May 30, 1925	June 5	May 29, 1926	June 16, 1939
Solitary Sandpiper (*Tringa solitaria*)	26	May 10	Apr. 29, 1905	May 18, 1936	May 17	May 14, 1906	May 27, 1917
Greater Yellowlegs (*Totanus melanoleucus*)	25	Apr. 23	Apr. 8, 1934	Apr. 30, 1947	June 2	May 20, 1921	June 13, 1946
Knot (*Calidris canutus*)	22	May 25	May 4, 1938	May 31, 1940	June 2	May 30, 1933	June 12, 1939
Least Sandpiper (*Erolia minutilla*)	35	May 12	May 2, 1941	May 22, 1943	June 1	May 27, 1924	June 15, 1946
Dunlin (*Erolia alpina*)	15	May 21	May 7, 1942	May 26, 1946	May 31	May 27, 1933	June 17, 1946
Short-billed Dowitcher (*Limnodromus griseus*)	18	May 21	May 4, 1938	May 27, 1942	May 29	May 22, 1937	June 6, 1931
Semipalmated Sandpiper (*Ereunetes pusillus*)	32	May 16	Apr. 30, 1928	May 25, 1943	June 11	June 1, 1918	June 20, 1939
Sanderling (*Crocethia alba*)	27	May 19	May 7, 1942	May 28, 1927	June 6	May 30, 1944	June 7, 1939
Laughing Gull (*Larus atricilla*)	24	Apr. 21	Apr. 9, 1938	May 2, 1932	—	—	—
Bonaparte's Gull (*Larus philadelphia*)	18	May 5	Apr. 4, 1948	May 19, 1921	May 27	May 22, 1948	June 13, 1927
Common Tern (*Sterna hirundo*)	28	May 14	May 5, 1932	May 25, 1925	June 3	May 26, 1924	June 13, 1931
Roseate Tern (*Sterna dougallii*)	17	May 14	May 5, 1932	May 26, 1949	May 28	May 21, 1939	June 21, 1936
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	12	Apr. 11	Mar. 30, 1927	Apr. 19, 1923	Apr. 29	Apr. 20, 1923	May 13, 1917
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	11	May 20	May 18, 1937	May 25, 1945	June 1	May 27, 1941	June 11, 1944
Tree Swallow (*Iridoprocne bicolor*)	35	Apr. 8	Mar. 24, 1921	Apr. 19, 1931	May 22	May 6, 1942	May 31, 1925
Bank Swallow (*Riparia riparia*)	14	May 3	Apr. 18, 1936	May 12, 1925	May 21	May 15, 1921	May 31, 1937
Cliff Swallow (*Petrochelidon pyrrhonota*)	12	May 1	Apr. 30, 1938	May 12, 1917	May 23	May 16, 1936	May 30, 1917
Winter Wren (*Troglodytes troglodytes*)	15	Mar. 29	Mar. 1, 1946	Apr. 10, 1943	Apr. 23	Apr. 17, 1927	May 5, 1928

Species	No. of Years	Arrivals			Departures		
		Average	Earliest	Latest	Average	Earliest	Latest
Hermit Thrush (*Hylocichla guttata*)	32	Apr. 14	Mar. 29, 1929	Apr. 30, 1928	Apr. 28	Apr. 20, 1938	May 19, 1917
Swainson's Thrush (*Hylocichla ustulata*)	34	May 13	May 2, 1914	May 23, 1924	May 22	May 18, 1918	May 31, 1936
Gray-cheeked Thrush (*Hylocichla minima*)	27	May 19	May 13, 1949	May 25, 1927	May 24	May 17, 1914	May 30, 1930
Ruby-crowned Kinglet (*Regulus calendula*)	36	Apr. 15	Mar. 29, 1924	Apr. 17, 1940	May 3	Apr. 27, 1949	May 19, 1917
Solitary Vireo (*Vireo solitarius*)	33	Apr. 25	Apr. 20, 1927	May 4, 1915	May 7	May 1, 1928	May 24, 1917
Tennessee Warbler (*Vermivora peregrina*)	30	May 17	May 8, 1927	May 23, 1935	May 25	May 17, 1922	June 9, 1917
Nashville Warbler (*Vermivora ruficapilla*)	34	May 6	Apr. 27, 1925	May 18, 1917	May 19	May 11, 1922	May 26, 1930
Parula Warbler (*Parula americana*)	38	May 5	Apr. 27, 1925	May 11, 1917	May 29	May 21, 1906	June 6, 1935
Magnolia Warbler (*Dendroica magnolia*)	36	May 10	May 5, 1914	May 17, 1917	May 26	May 11, 1918	June 2, 1917
Black-throated Blue Warbler (*Dendroica caerulescens*)	36	May 8	May 2, 1941	May 17, 1917	May 22	May 13, 1946	June 1, 1945
Blackburnian Warbler (*Dendroica fusca*)	36	May 14	May 2, 1914	May 24, 1932	May 24	May 14, 1919	June 2, 1917
Bay-breasted Warbler (*Dendroica castanea*)	27	May 19	May 7, 1932	May 25, 1931	May 24	May 14, 1919	June 2, 1917
Blackpoll Warbler (*Dendroica striata*)	38	May 14	May 7, 1938	May 19, 1917	June 5	May 29, 1914	June 13, 1927
Pine Warbler (*Dendroica pinus*)	30	Apr. 15	Apr. 1, 1921	Apr. 27, 1940	Apr. 23	Apr. 17, 1943	May 7, 1939
Palm Warbler (*Dendroica palmarum*)	36	Apr. 17	Apr. 3, 1938	May 2, 1934	May 1	Apr. 18, 1936	May 13, 1917
Northern Waterthrush (*Seiurus noveboracensis*)	38	May 7	Apr. 29, 1945	May 16, 1920	May 26	May 18, 1931	June 8, 1945
Mourning Warbler (*Oporornis philadelphia*)	14	May 25	May 21, 1932	May 27, 1914	June 4	May 29, 1943	June 10, 1928
Wilson's Warbler (*Wilsonia pusilla*)	33	May 17	May 8, 1914	May 24, 1939	May 23	May 17, 1914	June 10, 1927
Canada Warbler (*Wilsonia canadensis*)	38	May 12	May 9, 1943	May 24, 1917	May 30	May 21, 1914	June 10, 1945
Rusty Blackbird (*Euphagus carolinus*)	36	Mar. 21	Mar. 2, 1930	Apr. 10, 1948	Apr. 21	Apr. 1, 1919	May 15, 1917
Savannah Sparrow (*Passerculus sandwichensis*)	34	Apr. 9	Mar. 22, 1942	Apr. 23, 1930	Apr. 30	Apr. 24, 1927	May 9, 1936
White-crowned Sparrow (*Zonotrichia leucophrys*)	12	May 13	May 8, 1932	May 19, 1941	May 17	May 13, 1934	May 20, 1941
White-throated Sparrow (*Zonotrichia albicollis*)	38	Apr. 9	Mar. 26, 1937	Apr. 23, 1918	May 16	May 6, 1918	May 29, 1917
Fox Sparrow (*Passerella iliaca*)	38	Mar. 12	Feb. 24, 1925	Apr. 2, 1927	Apr. 7	Mar. 26, 1948	Apr. 24, 1940
Swamp Sparrow (*Melospiza georgiana*)	34	Apr. 10	Mar. 22, 1942	Apr. 25, 1936	May 8	May 1, 1944	May 24, 1917

Table 4

Fifty Common Summer Residents Arranged in Order of Average Dates of Arrival

Species	Average Arrivals	Dates of First Arrivals 1917	1923	1938	1940
1. Common Grackle	March 8	March 15	March 3	March 8	March 18
2. Redwinged Blackbird	March 9	March 15	March 17	Feb. 26	March 16
3. Eastern Bluebird	March 9	March 12	March 3	March 12	March 16
4. Robin	March 10	March 10	March 3	March 7	March 6
5. Eastern Phoebe	March 24	March 31	March 21	March 20	April 2
6. Yellow-shafted Flicker	March 25	March 25	March 22	March 20	April 7
7. Brown-headed Cowbird	March 26	March 22	March 30	March 20	April 2
8. Field Sparrow	March 27	March 24	April 4	March 20	April 2
9. Vesper Sparrow	April 1	March 31	March 27	April 2	April 5
10. Chipping Sparrow	April 13	April 1	April 8	April 12	April 17
11. Louisiana Waterthrush	April 18	April 22	April 21	April 12	April 16
12. Barn Swallow	April 18	April 20	April 22	April 3	April 6
13. Rufous-sided Towhee	April 19	April 21	April 17	April 2	April 25
14. Brown Thrasher	April 22	April 21	April 22	April 15	May 4
15. Rough-winged Swallow	April 22	May 10	April 21	April 3	April 27
16. House Wren	April 25	April 23	April 20	April 20	May 4
17. Black-and-white Warbler	April 25	April 21	April 27	April 19	April 19
18. Green Heron	April 27	April 22	April 21	April 24	April 27
19. Chimney Swift	April 28	April 21	April 29	April 24	May 1
20. Black-throated Green Warbler	April 30	May 11	April 27	April 28	May 4
21. Yellow Warbler	May 2	May 15	May 1	April 27	May 5
22. Catbird	May 2	May 5	April 30	April 29	May 5
23. Ovenbird	May 2	May 5	May 1	April 28	May 4
24. Spotted Sandpiper	May 2	April 28	April 28	April 29	May 10
25. Least Flycatcher	May 2	May 12	May 4	May 1	May 3
26. Wood Thrush	May 2	May 12	May 4	April 28	May 4
27. American Redstart	May 3	May 3	May 1	April 30	May 7
28. Prairie Warbler	May 4	May 18	May 4	April 27	May 11
29. Blue-winged Warbler	May 4	May 13	May 2	April 29	May 7
30. Yellowthroat	May 4	May 12	May 5	April 28	May 11
31. Baltimore Oriole	May 4	May 12	May 5	April 30	May 5
32. Chestnut-sided Warbler	May 5	May 17	May 4	April 28	May 7
33. Rose-breasted Grosbeak	May 5	May 15	May 4	May 2	May 10
34. Bobolink	May 6	May 9	May 5	May 1	May 8
35. Yellow-throated Vireo	May 6	May 17	May 5	April 30	May 4
36. Veery	May 6	May 10	May 10	May 7	May 6
37. Eastern Kingbird	May 7	May 18	May 5	May 2	May 7
38. White-eyed Vireo	May 7	May 19	May 7	April 23	May 6
39. Scarlet Tanager	May 8	May 19	May 8	April 30	May 10
40. Hooded Warbler	May 8	May 26	May 5	May 1	May 11

TABLE 4 (Continued)

Species	Average Arrivals	Dates of First Arrivals 1917	1923	1938	1940
41. Great Crested Flycatcher	May 9	May 19	May 9	May 3	May 11
42. Yellow-breasted Chat	May 9	May 18	May 12	May 4	May 16
43. Orchard Oriole	May 10	May 16	May 12	April 30	May 11
44. Red-eyed Vireo	May 11	May 19	May 13	May 4	May 7
45. Black-billed Cuckoo	May 13	May 18	May 12	May 5	May 26
46. Indigo Bunting	May 15	May 23	May 20	May 6	May 19
47. Common Nighthawk	May 15	May 25	May 7	May 6	May 8
48. Ruby-throated Hummingbird	May 15	May 13	May 17	May 3	May 22
49. Eastern Wood Pewee	May 18	May 30	May 22	May 13	May 15
50. Yellow-billed Cuckoo	May 18	May 19	May 26	May 21	May 29

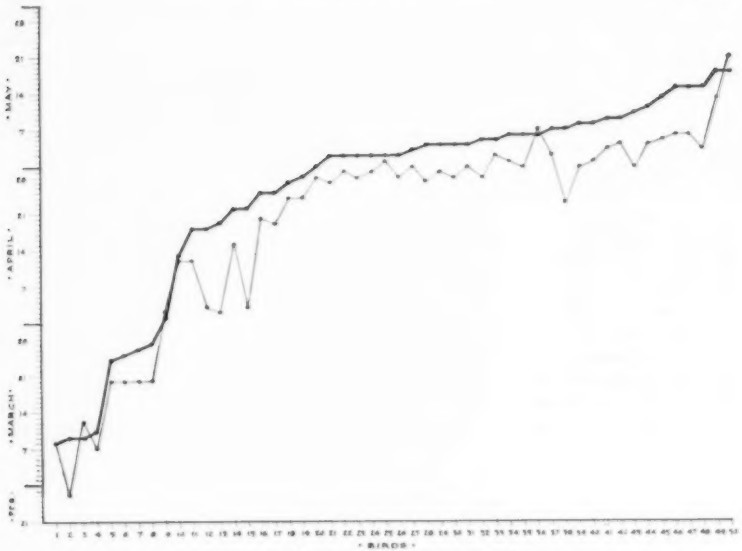


FIG. 1. Spring migration in 1938.[1]

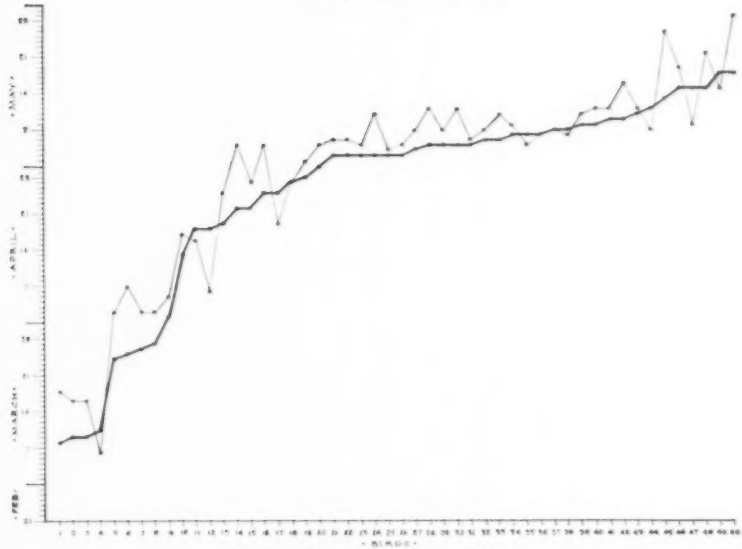


FIG. 2. Spring migration in 1940.

[1]For Figs. 1–4, the numbers 1–50 represent the common summer residents listed in Table 4; the thin line designates dates of arrival for the particular year, the thick line the dates of average arrival (Table 4).

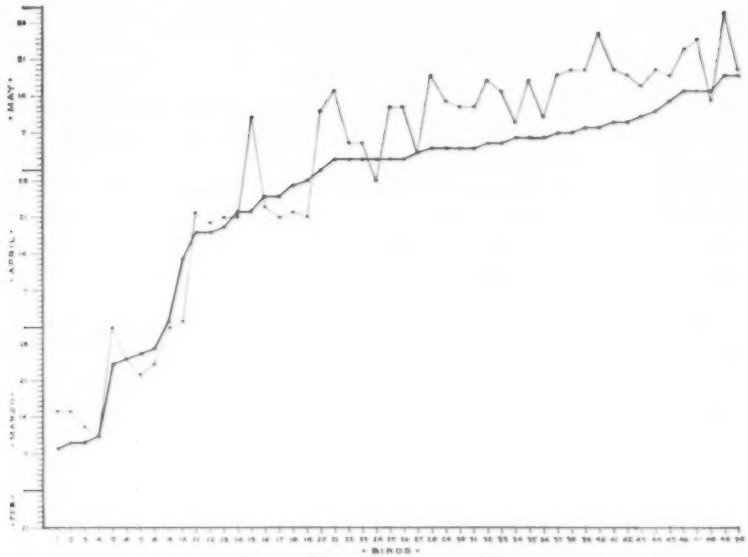


FIG. 3. Spring migration in 1917.

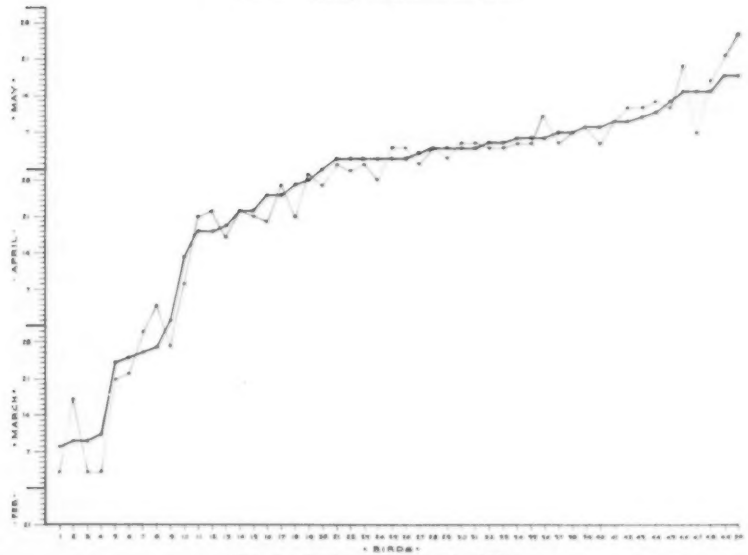


FIG. 4. Spring migration in 1923.

P. O. BOX 141, CANAAN, CONNECTICUT, JUNE 27, 1957

AN AUDIO TECHNIQUE FOR THE STUDY OF NOCTURNAL MIGRATION OF BIRDS

BY RICHARD R. GRABER AND WILLIAM W. COCHRAN

THE long-standing interest of ornithologists in nocturnal migration has, if anything, increased in recent years with the perfection of techniques for direct study of the phenomenon.

As early as 1880, Scott (1881) pointed out the potential value of lunar observations in the study of migration, and subsequently many workers have utilized the technique (see Carpenter, 1906; Lowery, 1951, for history and bibliography). Howell, Laskey, and Tanner (1954), and others have studied migration in the light of ceilometer beams.

Radar is a very promising tool (Sutter, 1957*a*, 1957*b*), and its use for study of migration is still in a development stage.

A technique which has been used almost as widely as that of lunar observation is the audio method based on detection of flight calls (Libby, 1899; Kopman, 1904; Tyler, 1916; Ball, 1952; and others).

Recently, Lowery and Newman (1955) summarized current knowledge on the subject of direct observation of nocturnal migration. These authors applauded the work of Ball (1952) but pointed out the basic limitations of the audio technique which he used. There are three principal shortcomings of the technique as used by Ball and others: (1) With the unaided ear, migrants can be heard only when they are flying low. Ball (1952:49) calculated that he could detect calls of *Hylocichla* thrushes to a maximum elevation of 1500 feet, but migrants may fly well above this range. Miller (1957) reported on a sparrow (*Zonotrichia*) migrating at 10,000 feet. (2) The unaided ear does not provide precise directional coverage of a measurable area of sky. (3) Variability in human hearing tends to invalidate comparative quantitative studies by different observers.

When these problems are solved it becomes possible to calculate the number of calls of migrants per unit of area of sky (flight-call density). The relationship of this quantity to true density of migrants is an unknown, but the solution of this larger problem depends first upon the perfection of the audio technique and then upon correlation of audio and visual methods. If the ratio of flight calls to observed birds is found to follow a definite pattern, then the audio technique will be useful for quantitative studies. In any case, the two methods complement each other, the visual method providing more precise quantitative data, the audio method qualitative.

We became interested in these problems while making observations on nocturnal migration in the spring, 1957. Using standard equipment which has found application in a variety of fields, we experimented and developed a promising method for detecting and recording migration.

It is the primary purpose of this paper to present detailed information on the technique and its development, and on the results of our tests with the equipment.

The technique was used to record migration in central Illinois in the fall of 1957, and in the spring and fall of 1958. Data from this nearly continuous record will be presented in another paper, but in order to show the potentialities of the audio method, we have included in the present paper graphs on five nights of migration, representing three seasons, along with a brief discussion of the data.

Acknowledgments

A number of people helped us in the development of the technique and in the pursuit of our studies on migration. We especially wish to express our appreciation to Frank Bellrose and other members of the staff of the Illinois Natural History Survey for encouragement and advice. Glenn Poor contributed substantially in the construction and maintenance of equipment, and particularly with the development of the timing device for the recorder. Jack Ellis and Ronald Labisky helped with the establishment of two of our study stations.

William G. Albright and George W. Swenson of the University of Illinois Electrical Engineering Department gave us valuable advice on the use of electrical equipment and loaned us equipment for making tests. Members of the staff of the University Antenna Research Laboratory kindly loaned us two large parabolic reflectors which were essential to the work. The University Physics Department also loaned us equipment for testing. Glenn E. Stout and other members of the Meteorology Section of the Illinois State Water Survey provided us with weather data. Tom N. Morgan and Jean W. Graber helped us with a number of engineering and ornithological problems.

Barney McMullin of Seymour, Illinois, kindly permitted us to establish an audio station on his property and donated electric power and shelter for our equipment.

Equipment and Method

Heretofore, workers studying migration with the audio method have depended on the unaided ear to detect the calls of migrating birds. Our method employs equipment (Fig. 1) which is basically the same as that used by several workers to record songs of birds. Radio broadcasters have also used parabolic reflectors or horns with their microphones for many years in order to pick up distant sounds. Thus, our only problem was to test and adapt already existing techniques to the particular problems of flight-call detection of nocturnal migrants. As one of our aims is to provide a relatively inexpensive, duplicable system employing readily available parts and equipment, we have made no attempt to approach the ultimate in detection equipment.

The essential items of equipment are: a sound gathering device (parabolic reflector or horn), a microphone, an amplifier, and a recorder. The parabolic reflector gathers sound over a large area (the aperture area of the parabola) and reflects it to a point (the focus) where a microphone or

speaker is located. The microphone converts the variations in air pressure (sound) into variations in voltage at its terminals. These voltage variations are in turn amplified by the audio amplifiers and finally fed to the recording head of a recorder and recorded on tape.

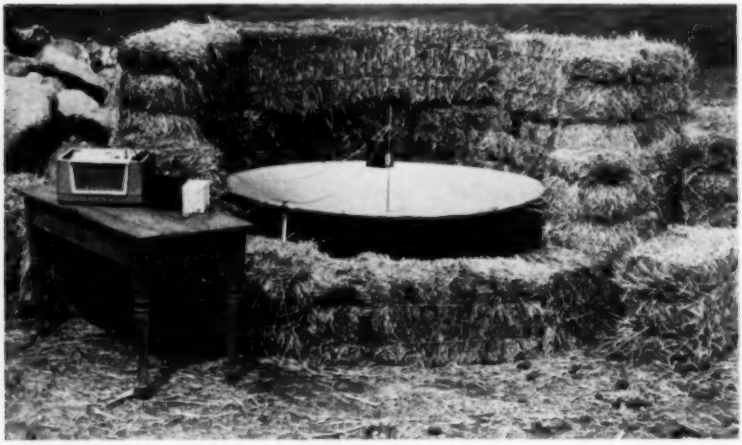


FIG. 1. Equipment used for flight-call detection of nocturnal migrants. From left: recorder, recorder timer, high-pass filter; parabolic reflector surrounded by straw sound baffle, and pre-amplifier with speaker (black box).

Because sound intensity varies inversely as the square of the distance, whereas the amount of sound picked up by a parabolic reflector varies directly as the square of the reflector's diameter, it is a rule of thumb that the maximum distance of detection will vary directly as the diameter of the parabola. Actually, doubling the diameter of a parabola may more than double the maximum distance of sound detection because the additional directivity obtained from the larger parabola will reduce the level of external interfering noise. Maximum range depends on four factors, three of which are in the category of equipment. These are: (1) the size of the parabola, (2) the sensitivity of the microphone, and (3) the sensitivity of the amplifier. The fourth factor, external noise, will in most cases be the limiting factor.

We used a large parabolic reflector (diameter, 72½ inches; maximum depth, 14¼ inches; and focal point, 19 inches), but a logarithmic-base horn might work as well and would probably be less expensive than the reflector.

To pick up sound gathered by the parabola we first tried several crystal microphones, all of which were satisfactory though with some variation in performance. Because crystal microphones deteriorate when exposed to the heat of the sun or to high humidity, we tried an inexpensive 4-inch permanent magnet (pm) speaker with a voice-coil-to-grid matching transformer. The speaker proved to be at least equal in performance to the crystal microphones, and with a thin coating of plastic spray over the cone it has withstood the weather through two seasons of operation.

Most tape recorders have a self-contained amplifier, but for this technique a pre-amplifier which provides additional amplification and a lower noise (internal hiss) level is essential. Many of the high fidelity pre-amplifiers on the market would be satisfactory with very little adaptation, but we obtained excellent results with a relatively inexpensive, simple amplifier which we made for this application. (See Fig. 2 for details of the electrical system.)

The speaker and amplifier were housed in a small metal box (4 × 5 × 6 inches), and the box was made weatherproof with gasket material, gasket seal, and copious quantities of paint.

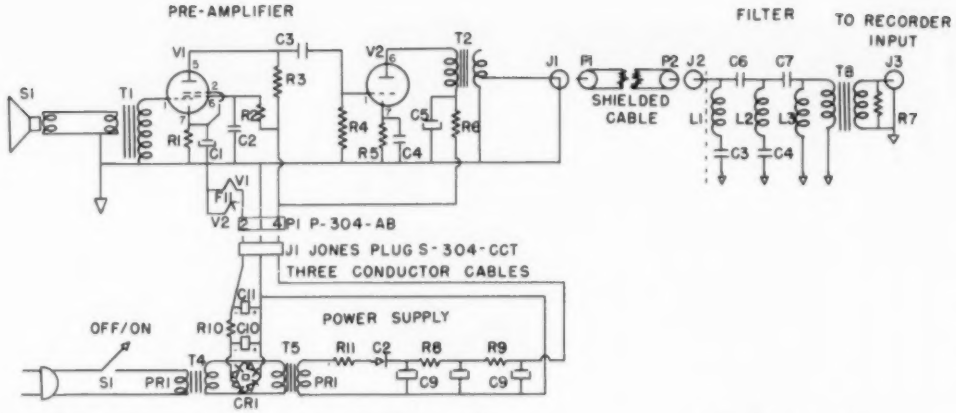
The amplifier box was clamped on a half-inch steel rod extending from the center of the parabola so that the open speaker end of the box was located at the parabola's focal point.

Sockets were provided on the amplifier box for power plug and output connection. Power for the pre-amplifier may be from batteries or from a power supply operating on 110 volts a.c. Initially, we used a 6-volt storage battery and a 90-volt dry cell to power the amplifier. Drain from the dry cell is so small (1.5 ma) that it will last almost shelf life, but the storage battery must be recharged after each 30–40 hours of operation. Our station now uses a power supply operating on 110 volts a.c. (See Fig. 2 for details.)

The output of the pre-amplifier may be fed directly into a pair of headphones to establish a listening post to study the sounds of nocturnal migration. If battery-powered, the equipment is portable, and, with a parabola mounted on truck or car, an investigator can check on migration at widely scattered locations during a single night.

With a fixed station, the output of the pre-amplifier can be carried over a considerable distance through shielded cable to a tape recorder located well away from the reflector in some permanent shelter.

In attempting to record sounds of migration we encountered numerous interfering sounds, many of which were of frequencies below 350 cycles per second. The inclusion of an appropriate high-pass filter (see Fig. 2) between the output of the pre-amplifier and the input of the recorder greatly attenuated frequencies below 350 cycles and improved considerably the range of the equipment without affecting reception of most bird calls.



S1–4" pm speaker 3.2~ v.c. P-950-4 OXFORD
R1–10K 1W.
R2–39 meg. aerovox CP-1/2 carbonfilm
R3–.5 meg. aerovox CP-1/2
R4–1 meg. aerovox CP-1/2
R5–2500~ 1W.
R6–20K 1W.
C1–25 mF 25V. electrolytic
C2–.1 mF 600V.
C3–.001 mF 600 V.
C4–.25 mF 400V.
C5–16 mF 450V. electrolytic
V1–6AV.5
V2–6C4

T1–Merit A-2923
T2–Thordarson 22S59
J2–female jack

T4,T5–Thordarson 26F67
PRI 117 vac sec 126V 2A
C9 – triple section 40/40/40 yf, 150 V.D.C. wkg. electrolytic.
R8,R9 – 20K 1W.
C10,C11–Cornell Dubilier 10001 1000 yf, 15 V.D.C. wkg.
R10–10~ 2W.
CR1–Sarkes Tarzian D-17 selenium full wave bridgerectifier

CR2–Federal 1389 65 m.a. selenium rectifier
S1 – toggle switch spst
R11–50~, 1W.

R7–120K 1/2W.
T3–Thordarson 20A34 transformer 500~/100K
L1,L2–Thordarson T-20C58 choke 0.75 hy
L3–J.W. Miller 6324 60-130 mhy, adjustable
C6,C7,C8,C4 – .5 mF 400V.

FIG. 2. Diagram of electrical equipment, pre-amplifier, filter, and power supply, used in audio technique.

Without a tape recorder, the investigator must be in constant attendance while data are being recorded. The addition of a tape recorder to the system permits the recording of migration without a full-time operator and provides a record which can be read and reread at the investigator's convenience. Furthermore, if more than one set of apparatus is available it becomes possible to make simultaneous "observations" at two or more localities.

In our work we used a standard model tape recorder (Revere T 10) with 7½-inch reels. Most standard recorders have recording speeds of 7½ inches and 3¾ inches per second. Even at the slower speed 2400 feet of tape will last less than two hours.

To obtain a nightly 8-hour record of migration during the fall of 1957, we altered the gear ratio of our recorder so that it ran tape at the rate of about two inches per second, and used specially made 14-inch aluminum reels that would carry over 6000 feet of 1½ mil audiotape. With the combination of slow recorder speed and large quantity of tape we could record continuously for over eight hours. To carry these large reels we had bicycle axles mounted on each side of the recorder at the level of the turntable. Several problems were involved in handling this amount of tape. Slowing the recorder speed reduced the fidelity of the recording, especially of high frequency sounds. Such heavy reels tended to burden the recorder and occasionally caused the machine to fail. The greatest drawback in the system was the vast amount of time required to collect the data. Each 8-hour record on tape required eight hours or more to audit. Timing the nightly migration involved correlating the start of recording time with the start of auditing time. Reading the tape was especially tedious for periods when there was little migration.

To remedy these problems we altered our equipment by inserting an automatic, intermittent timer in the circuit of the recorder. Glenn Poor of the Illinois Natural History Survey adapted an ordinary, furnace, stoker-hold, fire timer to open and close only the circuit of the reel-turning motor of our recorder. In operation the amplifier circuit of the recorder remains activated continuously. The timer may be wired to the recorder or arranged with a plug-in. It can be adjusted to obtain any length of recording sample at intervals as short as a few minutes or as long as an hour. Our device is set to take samples of 1½ minutes duration at 10-minute intervals. A maximum total sample of about 2–2½ hours may be recorded on a standard 7½-inch reel at a recording speed of 3¾ inches per second. For a larger sample, the investigator must either slow the recorder or make special reels to handle more tape.

When the timer initiates the recorder motor, a characteristic sound is recorded on the tape. Because these sounds come at regularly spaced, precisely timed, intervals, they facilitate the timing of migration during the night.

Interfering Sounds and Equipment Location

In using a high-gain amplifier system to study migration, the proper location of the equipment is very important. As the relatively weak signal of a bird call is amplified, so also are the sounds from outside sources—trains, highways, wind, livestock, etc.

There is no substitute for a good, quiet location, but filters in the electrical system (see above) can eliminate some of these extraneous sounds. If the investigator is interested in only one or a few species, filters could be used to eliminate virtually all sounds but those in the frequency range of the species being studied.

It is difficult to obtain good recordings of migration in an urban situation, though we did have some success with our equipment placed on top of the Natural Resources Building on the University of Illinois campus. For best results the equipment should be stationed in the country at least two miles from a railroad or major highway. We have found farmers to be most cooperative in permitting us to set up stations on their land. The cost of the electricity used by our equipment is almost negligible.

In any location, sound baffling around the parabola is essential. We used straw bales stacked three-high around the reflector, and found this to be an effective, durable baffle for a permanent station.

Some interfering sounds inevitably get through, or over, the baffle. Most of these are recognizable, but an occasional noise may cause confusion when the tape is read. Nonmigrating birds are a minor nuisance during the night. Many of our tapes have recorded owl calls, and a few have recorded songs of passerines. Relatively few migrants sing full songs in flight, though we have records for some species. It is usually possible to determine from the tape whether a singing bird is moving or stationary. In contrast to the lunar observation method, the present method can be used under a broad variety of weather conditions. Heavy winds (15–20 mph) interfere somewhat, and even moderate rains interfere completely because of the noise of raindrops striking the metal reflector. We have heard migrants during light rains, though the range of coverage is greatly reduced under these conditions. During the fall of 1957, not one of our nightly records was completely lost because of interfering sounds.

Range and Performance of the Equipment

We could not determine the vertical range (above the earth's surface) of our equipment, though we did obtain an accurate estimate of its range with tests conducted on a horizontal plane.

For the tests, we chose a site which offered an uninterrupted view (except for scattered trees and farm houses) of three miles. The area was flat except

for a slight rise at one edge on which we located the reflector. We placed the parabola on edge and baffled it with straw bales at the back and sides. Tests were made on three nights offering a variety of wind conditions.

To check on range and sensitivity of our apparatus we used as a sound source a mechanical noisemaker which emitted a frequency of 2500 cycles per second and which could be heard by the unaided ear at a distance of 1512 feet. By comparison, the call notes of individual House Sparrows (*Passer domesticus*) were audible by the unaided ear to a distance of approximately 1240 feet. In loudness, then, our noisemaker is more nearly comparable to the call notes of *Hylocichla* thrushes as calculated by Ball (1952:49).

In our tests, one person moved straight out from the face of the parabola, signalling at irregular intervals with the noisemaker only. A second person, the auditor, remained at the recorder listening for the signal. From his position at the recorder the auditor acknowledged reception of the sound by signalling with a flashlight. From the distribution of positive tests we plotted the range of the equipment.

Under favorable conditions, with no surface winds, the maximum range of clear detection of the sound signal was 11,400 feet or approximately 2.2 miles. Most flights of nocturnal migrants probably occur well below this height (Lowery, 1951:389).

Heavy winds reduced the range considerably. Tests made on a night when cross winds were 15 to 18 mph indicated a maximum range of 3500 feet.

The true vertical range of our equipment may be greater than the tests indicate. With the parabola in its normal position of vertical coverage, background noises would undoubtedly be less with the same wind conditions than they were in our tests, because wind noise results principally from the action of wind upon objects on the earth's surface. With the baffle that we used, the limits of coverage were sharply defined though, obviously, maximum sensitivity is obtained when the signal is emitted directly over the parabola.

The directional pattern of a parabolic reflector may be computed approximately by formulas (Williams, 1950:147–157). The theoretical pattern of our reflector for a frequency of 2500 cycles is shown in Fig. 3. On paper, the pattern can be represented in two dimensions only, although it is actually three-dimensional, having a shape somewhat like a cigar. The angle of coverage is approximately five degrees with a maximum width of 900–920 feet, at a distance of 8000 feet from the parabola.

Obviously, a broader space is covered, at the higher levels (6000–10,000 feet), and an individual bird would be in range of the parabola longer at these levels. Quantitatively, the significant figure is the number of birds crossing a given line on the earth's surface.

The directional pattern of a parabola varies with the vibration frequency

and intensity of the signal. Thus, loud calls of waterfowl would be detectable well beyond the range given for our tests, and, in calculating "flight-call density," these factors must be considered. The frequency range of the equipment (with filter) is from 350–5000 cycles per second using a recorder speed of 3¾ inches per second.

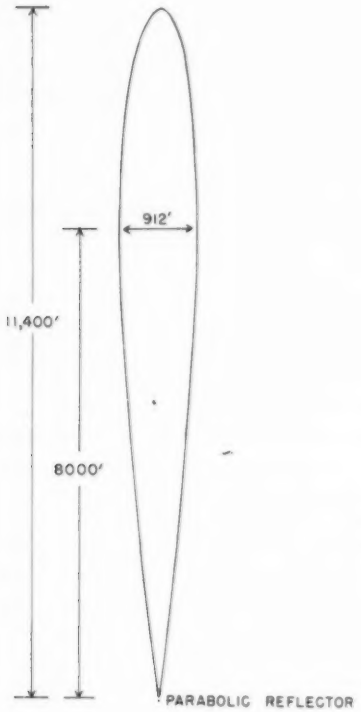


FIG. 3. Theoretical directional pattern of a 72-inch diameter parabolic reflector for a frequency of 2500 cycles per second or wavelength of 5.3 inches. The maximum range of detection of calls comparable in frequency and loudness to those of the *Hylocichla* thrushes is 11,400 feet. The maximum diameter covered is 912 feet at a distance of 8000 feet from the parabola.

Collection of Data and Sample Results

We have found the equipment described above to be very helpful in studies on nocturnal migration in the prairie region of east-central Illinois. With a semipermanent station, a nightly record of migration can be obtained with an expenditure of two to four hours per day, depending upon the location of the station and the length of the recording sample. The tape-recording must be started each evening, and the tapes retrieved and audited on the following day.

In transcribing data from the tapes we have phoneticized all call notes and, whenever possible, identified individual call notes. The time of calling was also noted in each case. From these basic data the accompanying graphs (Figs. 4–8) were constructed.

Though the audio technique in its present form is intended to complement direct visual studies, it can provide information on certain aspects of migration even without visual study.

The following discussions are based on the graphs and consider four general problems in which audio records may be helpful: (1) the hours of nocturnal migration and of calling by nocturnal migrants, (2) flight-call density, (3) the kinds of calls of nocturnal migrants, and (4) the conditions under which migration occurs.

Hours of Nocturnal Migration and Calling of Migrants

Data from visual and audio studies have been contradictory as to the hours of the night when migration occurs. From lunar observations at many localities, Lowery (1951:415–416) determined that maximum densities of migrants occurred before 1 a.m., with peak numbers coming between 10 p.m. and 1 a.m. Using an audio method in Gaspé, Ball (1952:55) found that there were two peaks during the night, one before 10 p.m. and a second between 3:30 a.m. and dawn.

Our recordings (for 125 nights) show only one *consistent* pattern. In central Illinois, migration may be detected at any hour during the night from sundown to sunup, but if migration continues until dawn there is often a marked increase in calling by migrants in the predawn hours. This peak depends at least upon the species of migrants involved and the factors which affect the intensity of dawn light. Increased calling at this time is particularly characteristic of the *Hylocichla* thrushes, but probably also occurs in other species. The predawn peak in calling does not necessarily indicate that more birds are flying at that time. The peak may reflect an increased incidence of calling only, and not an actual increase in flight density. Our observations on a captive flock of six Swainson's Thrushes (*Hylocichla ustulata*), five Gray-cheeked Thrushes (*H. minima*), and one Veery (*H. fuscescens*) for a week in

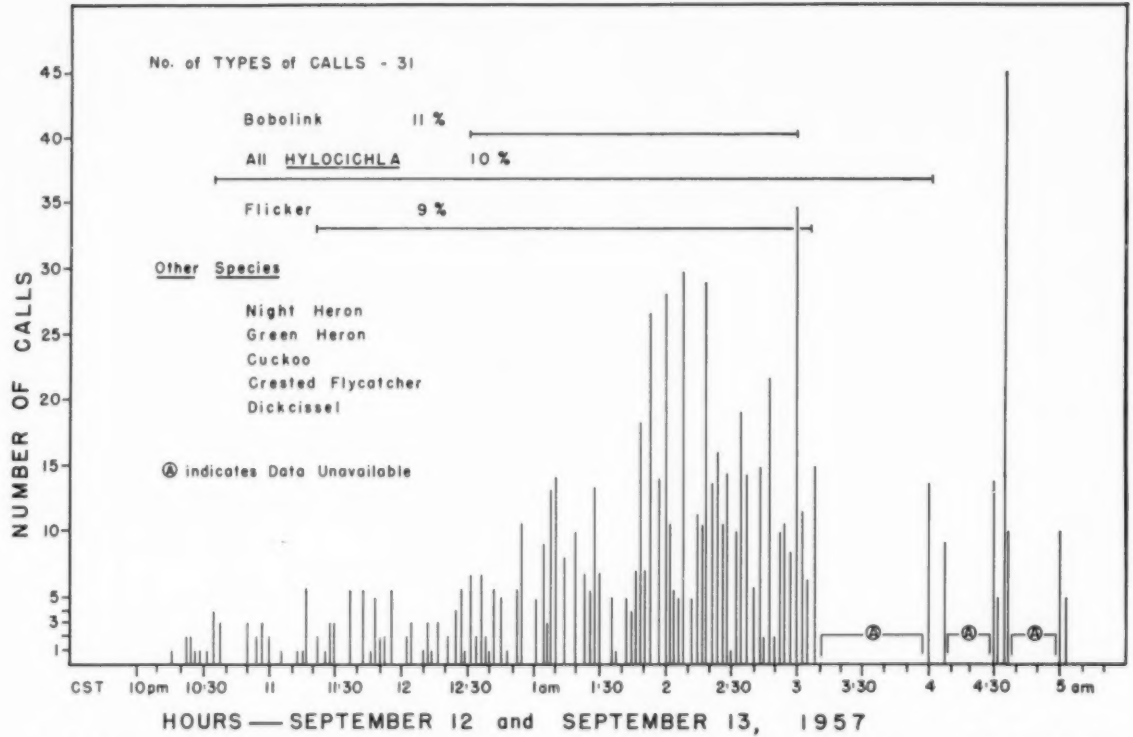
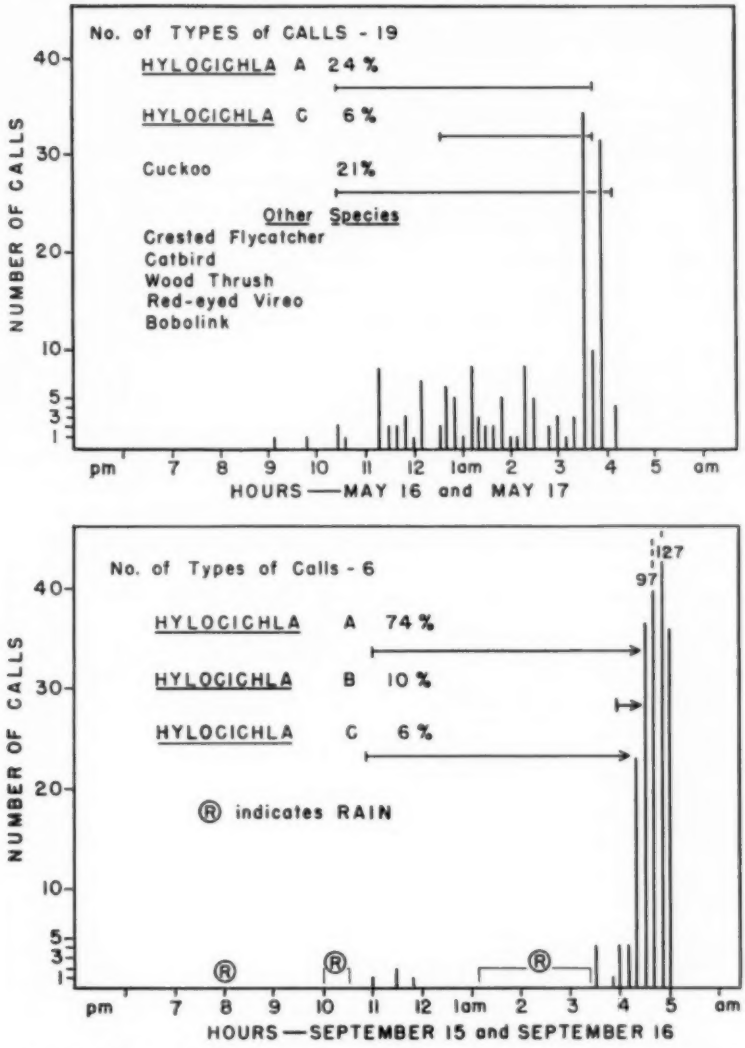
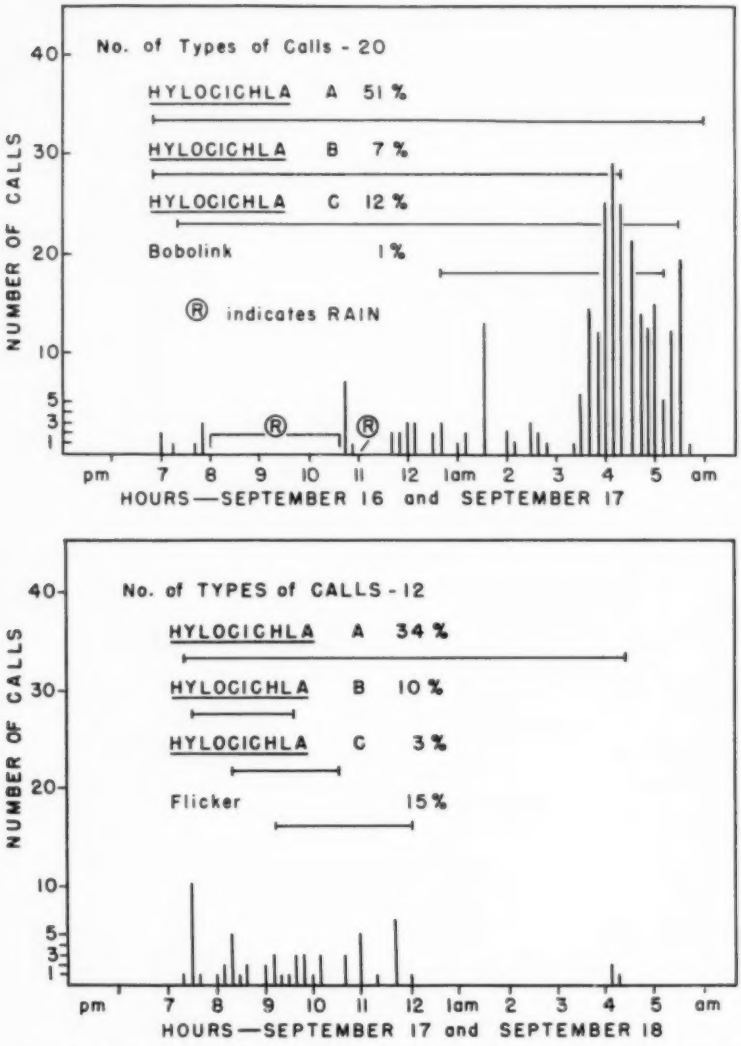


FIG. 4. Record of calls of nocturnal migrants transcribed from a continuous tape recording made on the night of September 12–13, 1957. Gaps marked "A" represent periods of power failure. Percentage figures represent per cent of total calls.



FIGS. 5 (above) and 6 (below). Records of calls of nocturnal migrants passing through a circular area with a maximum diameter of 912 feet on nights in 1958, near Champaign, Illinois. Histograms show number of calls recorded in 1½-minute periods every 10 minutes during the nights. Percentage figures represent per cent of total calls.



FIGS. 7 (above) and 8 (below). Records of calls of nocturnal migrants passing through a circular area with a maximum diameter of 912 feet on nights in 1958, near Champaign, Illinois. Histograms show number of calls recorded in 1½-minute periods every 10 minutes during the nights. Percentage figures represent per cent of total calls.

mid-September, 1958; and on two captive Gray-cheeks for three weeks in October corroborate the view that although these birds may call at almost any hour of the night, they actually call with greatest frequency in the predawn period.

It seems reasonable to assume that if some species, say Swainson's Thrush, is heard calling throughout the night the number flying may be just as great early in the night as late, but that a higher proportion of these thrushes call just before dawn than during the rest of the night.

Figs. 6–8, which show one complete migratory wave in the fall of 1958, help explain that any number of nightly patterns of migration may exist. Our recording station showed no evidence of nocturnal migration after 1 a.m. on September 15, but at 10:50 p.m. on September 15, the first loud calls (probably Gray-cheeked Thrushes) were recorded for a migration that was to continue throughout the night hours until the early morning of September 18 (Figs. 7 and 8). On the following night (September 19) there was little migration, and none of thrushes.

These records show that at least certain species of nocturnal migrants fly throughout the night as long as conditions prevail which favor migration.

Assuming a take-off time of 6:30 p.m. (September 15) and a flight speed of 35 mph, the first migrants of this wave probably started about 150 miles north of Champaign. If the front edge of this wave continued to move through the night hours as long as birds passed the Champaign station, the migration would have carried an individual bird about 900 miles by the morning of September 18, when the last birds passed Champaign.

The nightly migration patterns, then, at any given station depend upon the extent of the mass movement, the relative positions of the leading and trailing edges of the migrating mass of birds, and the geographic extent of the conditions which favor or retard migration.

Our data do not completely explain the discrepancy in nightly patterns of migration as determined by auditing with the unaided ear (Ball, 1952:55), and by lunar observations (Lowery, 1951:418). Both Lowery (1951:419) and Ball (1952:57) considered the possibility that migrants may fly higher (thus out of hearing) during the middle hours of the night than during the early and late hours of darkness. Both authors dismissed the possibility as improbable, but our data suggest that such an arc flight may be a reasonable explanation.

Flight Call Density

Fig. 4 shows the distribution and number of calls of nocturnal migrants during a heavy migration on the night of September 12–13, 1957. This record, in contrast to those shown in Figs. 5–8, is based on a continuous 7-hour tape

recording, and the distribution of calls suggests that migrants were flocked, not evenly distributed in the sky. Ball's (1952:57) data also suggest an uneven (flocked) distribution of migrants. However, Lowery (1951:410) and Lowery and Newman (1955:246) present overwhelming evidence that nocturnal migrants are relatively evenly distributed in flight. It is entirely possible that it is only the calls, not the migrants, which have a "clumped" distribution. In fact, during the predawn peak in calling when the highest proportion of migrants are calling, the distribution of calls is not "clumped," but uniform and continuous.

In calculating flight-call density we have used the figures for the predawn peak as an index because they probably most nearly represent the true numbers of birds in flight.

Figs. 5 and 6 show peak numbers of calls per 1½ minutes for the heaviest migrations recorded in the spring (34) and fall (127) of 1958. These calls were emitted in an area with a maximum diameter of 912 feet. Lowery (1951: 434–436) gives spring flight-densities (number of birds crossing any part of a circle one mile in diameter per unit of time) for several localities. A maximum nightly density for Ottumwa, Iowa, in May was 54,600 birds. By comparison, the flight-call density for Champaign in spring (May 16–17) was 78,800 calls per 10 hours and in fall (September 15–16), 294,000 calls.

With regard to these calculations, the question arises as to whether an individual bird calls more than once as it flies through the area covered by the parabola. There is variation in frequency of calling between species and even by individual birds. Ball (1952:54) stated that a single Hermit Thrush (*Hylocichla guttata*) called at intervals of 12–13 seconds on a straight course, while in a curving flight down a hill slope it called at intervals of 6–9 seconds. Our observations in the vicinity of the Champaign audio station during many night and dawn periods of the past two years indicate that in the majority of cases each recorded call note represented a different bird. In straight flight at an average speed of 35 mph a given bird would be in range of the parabola for a maximum possible period of 18 seconds. Again our observations on captive thrushes are pertinent. In this flock, even in the predawn period, individual birds called only at intervals of several (2–45) minutes during nights in September and October.

Identification of Call Notes

The identification of species of birds from their nocturnal calls uttered in migration is a field of study in itself, and one which deserves more attention.

Some call notes may be learned through observations of migrants at dawn. Some birds may still be flying at this time, while others have alighted. An

even better method is to listen to captive birds during periods when they exhibit *zugunruhe*.

We have been able to identify only a low percentage of the total number of calls on our tapes, and even so our identifications must be considered tentative. In Figs. 4–8 we have used letter designations for the thrushes rather than species names. "*Hylocichla* A" is probably Swainson's Thrush. The letter actually designates two types of calls which we have phoneticized as *whit* and *wheek*. We have heard Olive-backed Thrushes utter both these calls. "*Hylocichla* B" represents a call note which we phoneticized as *pee-oort*, while "C" represents the note *peer*. The latter two we have heard from Gray-cheeked Thrushes, but there is a possibility that the Veery may utter similar cries in migration.

Weather Conditions which Accompany Migration

Potentially, one of the most valuable types of data to be gained from audio studies is information on the conditions under which migration occurs.

For example, the mass migration of September 15–18, 1958 (Figs. 6–8), occurred largely with conditions of complete cloud cover and intermittent rains. At Champaign there was continuous 10/10 cloud cover from 7 a.m. September 15 until 7 p.m. September 17. At least part of this time the clouds were in three layers: 8/10 low stratus (top level at 1300–1500 feet), 3/10 strato-cumulo (base at 7000–8000 feet), and 10/10 probable ice clouds (base at 15,000–20,000 feet). Daily weather maps issued by the U. S. Department of Commerce for these dates show that the 10/10 overcast was extremely widespread, covering most of the states of Illinois, Wisconsin, Indiana, Iowa, and Missouri.

In the evening of September 16, birds began migrating at least by 6:35 p.m., not having seen direct sunlight all day at Champaign. Migration continued throughout the night with the possible exception of the periods of intermittent rain (see Fig. 4), at which times the audio technique was useless. It is possible that migrants actually flew through the rains because migrants were recorded immediately before and immediately after the precipitation. It is also possible that the birds were flying above the rain, but they had to be flying below the 15,000-foot ceiling or they would not have been detected by the audio equipment.

Under the conditions mentioned it does not seem likely that migrants were using celestial orientation as described by Sauer (1958:44).

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CALCULATION OF FLIGHT DIRECTIONS OF BIRDS OBSERVED CROSSING THE FACE OF THE MOON

BY I. C. T. NISBET

THE classic paper of Lowery (1951) on the study of nocturnal migration by observing birds passing in front of the moon has established this technique as an important part of the field study of migration. Most migration students are unable to use it, however, because of the mathematical calculations necessary to reduce the observational data. The purpose of this paper is to provide instructions by which any observer, armed only with a telescope, a compass and a protractor, may perform these calculations without technical assistance.

The observational method and the theory of the calculation are described by Lowery at considerable length, and reference should be made to his paper for more details than can be given here (see also Appendix). The chief difficulties arise from the oblique angle at which the birds are viewed, which distorts the direction in which they are actually flying. This effect becomes more serious as the moon becomes low in the sky, and when it is close to the horizon the birds' flight directions cannot be determined at all. Even if observations are avoided in these circumstances, a mathematical treatment is usually necessary before directions of flight can be determined with any accuracy.

Lowery avoided this difficulty in part by processing the data from all his collaborators himself, but this procedure was so time-consuming that he was forced to adopt a method of approximation, grouping the data before making the calculation. However, Tunmore (1956) has recently pointed out that Lowery's approximation might lead to large errors if it should be used when the moon is low in the sky. A method of grouping will be described here which introduces errors no larger than those inherent in the observational method itself.

OBSERVATIONS

Position of the Moon.—To reduce the data it is necessary to know the compass direction and altitude (angle of elevation) of the moon at the time that each bird is seen. As Lowery explains, this information can be obtained from published tables, but these tables are not generally available and it is much simpler to measure the angles directly.

The compass direction should be measured in degrees (North, 0° or 360°; East, 90°; South, 180°; West, 270°; etc.). A correction is added or subtracted for the difference between true north and magnetic north (in the United States, for example, the local correction is given on the topographic maps published by the U. S. Geodetic Survey), and the result is the azimuth angle Z.

The altitude is measured by attaching a protractor, with a plumbline (thread and small weight) hanging *freely* from its *exact* center, to the side of the telescope so that the base of the protractor is exactly parallel to the line of sight (see Fig. 1). When the moon is in the center of the telescope field the position of the thread on the protractor scale is read and the reading subtracted from 90°; this gives the altitude A in degrees.

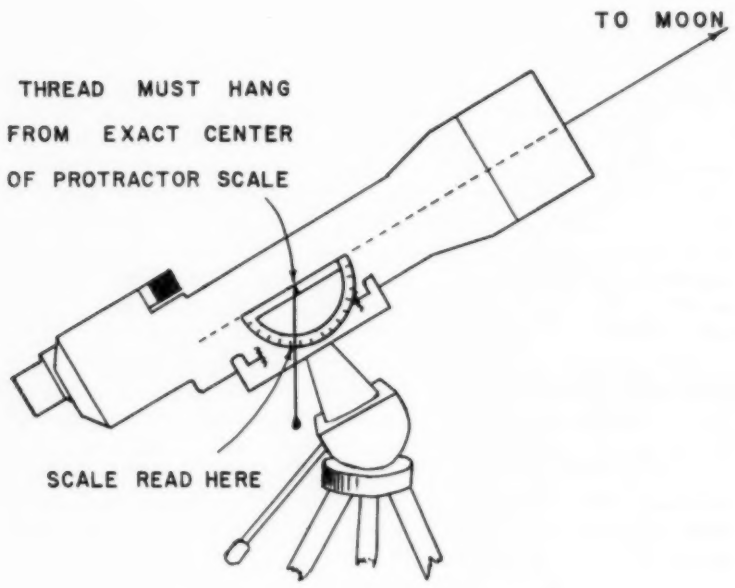

FIG. 1. Attachment of protractor to telescope.

Each of these measurements should be made at frequent intervals, about once every half hour and at least four times in all during the observation period. At the end of the period each of the angles is plotted against the time of the reading on a piece of graph or squared paper, and smooth curves are drawn through the points, averaging out small errors in measurement. It should then be possible to read off from the curves the exact azimuth and altitude of the moon at any intermediate time, within five degrees for the former, and two degrees for the latter.

If the altitude of the moon is less than 14° the calculation should not be made at all: observations made in these circumstances have only a qualitative value.

Apparent Directions of Flight.—Observations are best made with a low power telescope (15× to 20×) on a rigid tripod mounting; the latter is essential, not only for comfort, but also for the measurement of the altitude which was described above. At least two collaborators are required, one to observe and one to record the data, and positions should be changed frequently to avoid fatigue and eyestrain. The period for which the moon is kept under continuous scrutiny must be recorded exactly, with note of any interruptions, such as those which occur when the observers change positions.

The apparent flight direction of each bird is estimated by visualizing a clock-face on the moon, with 12 o'clock at the top. The "hours" at which the bird appears to enter and leave the moon are noted, to the nearest half-hour unless the bird is flying more or less "vertically" (e.g., from 5 o'clock to 2), when it is sufficient to record to the nearest hour. This information is recorded for each bird, together with the time to the nearest minute and any other relevant information.

(The observational method recommended here is exactly that described by Lowery, and his paper should be consulted for fuller details.)

Calculations

The method of calculating the flight direction of a single bird will be outlined first, and the grouping of the data discussed later.

Flight Direction of a Single Bird.—(1) The "hours" at which the bird entered and left the moon are used to obtain an angle B from Table 1. This is the angle which the bird appears to make with the horizontal, and the remainder of the calculation consists in its correction for the effect of foreshortening.

(2) If B is not 0° or 90°, the moon's altitude A at the time of the observation is determined from the graph, to the nearest 2° if less than 22°, to the nearest 5° if between 25° and 50°, to the nearest 10° if over 50°. From the two angles B and A a new angle C is obtained from Table 2. If B is 0° or 90° there is no correction and C is the same as B.

(3) The moon's azimuth Z at the time of the observation is obtained from the second graph.

(4) It is now necessary to note whether the bird appeared to be flying upwards or downwards, and whether to the left or right (e.g., 8 o'clock to 2 is up and right, 2 to 8 is down and left). Four possibilities arise:

Up and right: add 90° to Z and add C.

Down and right: add 90° to Z and subtract C.

Down and left: subtract 90° from Z and add C.

Up and left: subtract 90° from Z and subtract C.

The result is the true flight direction of the bird in degrees (if negative, 360° is added; if over 360°, 360° is subtracted).

TABLE 1

DETERMINATION OF THE ANGLE B, THE APPARENT DIRECTION OF FLIGHT

Hour of entering:	12	1	2	3	4	5	6	7	8	9	10	11
Hour of leaving												
12	X	15	30	45	60	75	90	75	60	45	30	15
1	15	X	45	60	75	90	75	60	45	30	15	0
2	30	45	X	75	90	75	60	45	30	15	0	15
3	45	60	75	X	75	60	45	30	15	0	15	30
4	60	75	90	75	X	45	30	15	0	15	30	45
5	75	90	75	60	45	X	15	0	15	30	45	60
6	90	75	60	45	30	15	X	15	30	45	60	75
7	75	60	45	30	15	0	15	X	45	60	75	90
8	60	45	30	15	0	15	30	45	X	75	90	75
9	45	30	15	0	15	30	45	60	75	X	75	60
10	30	15	0	15	30	45	60	75	90	75	X	45
11	15	0	15	30	45	60	75	90	75	60	45	X

Note: directions corresponding to "half-hours" can be obtained by interpolation.

Accuracy.—The accuracy of the calculated flight direction may be estimated from Table 2. Assuming that A and B are correctly observed to the nearest figure given in Table 2, and that Z is measured correctly to the nearest multiple of 5°, the following estimates are obtained for the maximum possible error introduced by the approximations used in the calculation:

Moon's altitude A:	14°	16°	20°	30°	40°	60°
Max. error in direction:	20°	18°	15°	13°	12°	12°

The probable error of each calculated direction will be roughly one-third of the maximum error given in the above table.

Two other sources of error are not included in the above estimates: the possibility that the bird may not be flying exactly horizontally (which would lead to error in determining B), and errors in observation. Both may become serious as the moon becomes low in the sky—a mistake of "half an hour" in recording the apparent direction of flight, for example, leads to an error in the calculated flight direction which approaches 30° if the altitude of the moon falls below 15°—and the results should always be evaluated with this in mind.

TABLE 2

DETERMINATION OF THE ANGLE *C*

Moon's altitude *A*	Apparent direction of flight *B*						
	7½	15	22½	30	45	60	75
14	29	48	60	67	76	82	86
16	26	44	56	64	75	81	86
18	23	41	53	62	73	80	85
20	21	38	50	59	71	79	85
22	19	36	48	57	69	78	84
25	17	32	44	54	67	76	84
30	15	28	40	49	63	74	82
35	13	25	36	45	60	72	81
40	12	23	33	42	57	70	80
45	11	21	30	39	55	68	79
50	10	19	28	37	53	66	78
60	9	17	26	34	49	63	77
70	8	16	24	32	47	62	76

Note: if the moon's altitude is greater than 70° the birds are almost vertically overhead, and their flight directions should be estimated directly.

Grouping of the Data.—Once the above calculation has been carried out a few times, it should be possible to perform it quickly and accurately. It is then possible to reduce the labor of analysis by judicious grouping of the data.

I have found useful the following method of grouping. The data sheet is ruled into columns, with one column devoted to each step in the calculation, and one line to each bird. Two columns record, for easy reference, the variation of the azimuth *Z* and altitude *A* of the moon through the observation period. Then a single calculation suffices for all the birds with the same apparent angle of flight *B* and the same values of *A* (within the accuracy demanded by Table 2) and *Z* (within the nearest five degrees). These criteria usually permit the grouping in 15- or 20-minute periods of all birds flying in the same apparent direction, and the limits of error quoted in the preceding paragraph are not exceeded.

FLIGHT DENSITY

Before the results can be used for quantitative studies of migration, it is necessary to calculate the flight density (e.g., the number of birds crossing a mile front in an hour) from the number of birds seen. However, this calculation requires an assumption to be made concerning the variation of the density with height. Using the scanty data then available, Lowery (1951) assumed for the purposes of calculation that the flight density was uniform with height up to a ceiling of one mile. Recent work by Harper (1958) suggests that this

assumption is reasonably good, in that nocturnal migrants in southern England usually fly at heights between 2000 and 5000 feet, and to give figures comparable with Lowery's the same assumption will be used here. However, variations in the average height of migration (such as those found by Harper) would have a serious effect on the calculated flight densities (see Appendix), and until a method is devised to detect such variations the results cannot be quantitatively accurate. Hence, there is no need to perform the calculation with great accuracy.

For each hour of observation, the numbers of birds seen flying in each direction are grouped under 22½° headings, and a correction is made for any gaps in observation to give an estimate of the total number of birds crossing the moon in each 22½° sector per hour. The altitude of the moon in the middle of the hour is noted, and used to obtain a correcting factor from Table 3: if the birds are flying more or less "horizontally" (e.g., 8 o'clock to 4), factor X is used; if they are flying more or less "vertically" (e.g., 1 o'clock to 5), factor Y is used. Approximate correcting factors for oblique directions can be obtained by interpolation. The number of birds seen per hour is multiplied by the correction factor: this gives an estimate of the number of birds crossing a mile front per hour, in the direction concerned (this quantity is termed the "Sector Density" by Lowery).

TABLE 3

CORRECTION FACTORS FOR DETERMINING FLIGHT DENSITIES

Moon's altitude A:	15°	20°	25°	30°	35°	40°	45°	50°	60°	70°	90°
Correction factor X:	15	30	40	60	80	100	120	140	180	210	240
Correction factor Y:	60	80	100	120	140	150	170	180	210	220	240

ACKNOWLEDGMENTS

I am greatly indebted to James Baird, who encouraged me to write this paper, gave much advice in its preparation, and drew the diagram. Dr. G. H. Lowery, Jr., also read the paper in draft and made valuable suggestions.

SUMMARY

Instructions and tables are given from which observers without mathematical training can calculate flight directions and approximate densities of migrating birds observed flying across the face of the moon. Estimates are given of the accuracy of the results.

The mathematical theory of the calculations is outlined in an Appendix. It is pointed out that the results obtained for the flight density depend critically on the distribution of migrating birds with height, which is not yet known.

Appendix: Mathematical Background

The method described above for computing flight directions is derived from an equation equivalent to Lowery's equation (1), namely,

$$\tan\,(\tfrac{1}{2}\pi + \eta + Z) = \operatorname{cosec} A \tan B,$$

where η is the bird's flight direction, A and Z are the altitude and azimuth of the moon, and B is the apparent direction of the bird's flight across the imaginary clock-face, measured counterclockwise from the line from 9 o'clock to 3. The only assumptions used in deriving this equation are that all the birds are flying horizontally and that the earth is flat.

The density of migration is calculated by assuming a distribution with height h (measured in miles) of $f(h)$ birds per mile front per hour. Thence, assuming that the birds are flying randomly, not in flocks, the correction factors are:

$$X = \frac{120 \sin^2 A \int_0^\infty f(h)\,dh}{\int_0^\infty h\,f(h)\,dh}; \qquad Y = X \operatorname{cosec} A,$$

under the approximation that the moon subtends an angle of 1/120 radians at the surface of the earth. Using Lowery's simplifying assumption that $f(h)$ is constant up to $h = 1$ mile and zero above this, we obtain:

$$X = 240 \sin^2 A; \qquad Y = 240 \sin A,$$

the values given in Table 3. The correction factors do not depend strongly on the *shape* of the assumed distribution: if, for example, we assume $f(h) = h \exp(-2h^2)$, a more realistic distribution which falls to zero at the ground, peaks at $h = \frac{1}{2}$ mile and drops off rapidly above $h = 1$ mile, they are altered by only 25 per cent. However, if two possible distributions have the same shape but differ in scale-height, the number of birds seen will vary directly with the scale. For example, if the total flight density remains unaltered but the ceiling falls from $h = 1$ mile to $h = \frac{1}{2}$ mile, the number of birds actually seen will be halved, and the estimate of flight density will be wrong by a factor of two. As Lowery points out (1951:389–390), hour-to-hour or night-to-night variations in the average height of the migrating birds cause serious errors in the quantitative estimates of flight density.

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SONG AND TREE SPARROW WEIGHT AND FAT BEFORE AND AFTER A NIGHT OF MIGRATION[1]

BY CARL W. HELMS

THERE has been much recent interest in weight and fat increases before and during migration, particularly in sparrows and buntings (Emberizinae). These weight and fat increases, representing reservoirs of stored energy which may be used during migratory flight, have been well documented for the White-throated Sparrow (*Zonotrichia albicollis*) by Odum (1949). However, Nice (1937) found no weight increase in Song Sparrows (*Melospiza melodia*) during migratory periods. Wolfson (1945:117–118) suggested that the presence of resident individuals obscured any weight increase which might have been shown by migrant birds. Nice (1946) reanalyzed her data, but found no weight increase in migrants. Farner (1955) cautions us that physiological adjustments during migration may be different in different species.

Helms and Drury (1959), comparing weight and fat variation in winter and migrant Tree Sparrows (*Spizella arborea*) and Slate-colored Juncos (*Junco hyemalis*) find that such differences between species do exist. Although no statistically reliable weight and fat increases were found to be associated with migration in Tree Sparrows, weight and fat variation become temperature-independent and are therefore subject to some other control, presumably associated with migration. In order to determine whether migratory birds such as Song and Tree Sparrows show any weight and fat increase with migration, and since this increase is not shown by mean data during migratory periods, it is important to gather statistically reliable data before and after a migratory flight is known to have occurred. Comparison of these data with one another and with means from mixed "resident" and "migratory" populations of the species might permit clarification of this problem.

The purpose of this paper is to present weight and fat data collected before and after a migratory flight, and from these data and that of Helms and Drury (1959), tentatively propose two distinct patterns of weight-fat variation in emberizines.

METHODS

Between April 4 and 6, 1958, while "mist-netting" in the "Pine Woods" area on Plum Island, Parker River National Wildlife Refuge, Newburyport, Massachusetts, I caught a number of migrant Song Sparrows. From April 5 to 6, there was a reduction from about 5000 to 2000 Song Sparrows on the island as estimated by roadside counts (the resident population was about 300 birds). The evening of April 5 was partly cloudy with light southwesterly

[1] Contribution Number 10 from The Hatheway School of Conservation Education.

winds. Mean temperatures were as follows: April 4, 42°F.; April 5, 48°F.; April 6, 44°F. Although no migratory departure of buntings was seen, about 200 Horned Larks (*Eremophila alpestris*) were observed leaving a marshy area just at dark and flying north. Isolated flight calls were heard during the early part of the night, indicating a general northward movement of several species of early migrants. Individual Song Sparrows were observed feeding and moving north during the day of April 5. On April 6, I caught only four birds which had been banded the previous day (two were residents and two had been weakened by our taking of blood samples). These facts indicate a general migratory movement during the day of April 5, and particularly that night along this part of the Atlantic coast.

Acknowledgments

This work has been supported financially by the National Science Foundation and the Massachusetts Audubon Society. I wish to thank Marilyn Flor, Alan Goodridge and Jack Hailman for help in the field, Gordon T. Nightingale for permission to band on the refuge, and William H. Drury, Jr., Terrell H. Hamilton, and Andrew J. Meyerriecks, who read the manuscript and made many helpful suggestions.

Song Sparrow

Morning weight and fat data for Song Sparrows captured before and after this migratory movement are summarized in Table 1. These data are shown graphically in Fig. 1.

Table 1

Song Sparrow Weight and Fat Before and After a Night of Migration

	Sample Size	Mean Weight	Range	S. D.	S. E.	Fat
Pre-flight Data (April 5, 1958)	61	22.48	18.2-26.4	1.67	0.21	2.35
Post-flight Data (April 6, 1958)	44	21.07	17.4-26.2	1.61	0.24	1.40

Key: Sample Size = number of individual weights (n); Mean Weight = average weight in grams; Range = lowest and highest weights in grams recorded; S. D. = standard deviation, a statistical measure of spread of weight values on either side of the mean; S. E. = standard error, a measure of reliability of the sample. For an explanation of fat values, see text.

The mean weight, as indicated in Table 1, was 1.41 grams lower on the morning of April 6 than before migration on April 5. This difference is statistically significant ($P = <.001$, *i.e.*, there is less than one chance in 1000 that this difference could have occurred by chance). Afternoon weights on April 5 (mean weight in grams = 22.86; S.D. = 1.88; S.E. = 0.50) are excluded, since, due to rain, I have no comparable weights on April 6.

Fat reserves of all birds handled were determined visually as described by Helms and Drury (1959); they were assigned numbers from one to five (our "no fat" class, Class 0, is found only during post-nuptial molt). Birds in

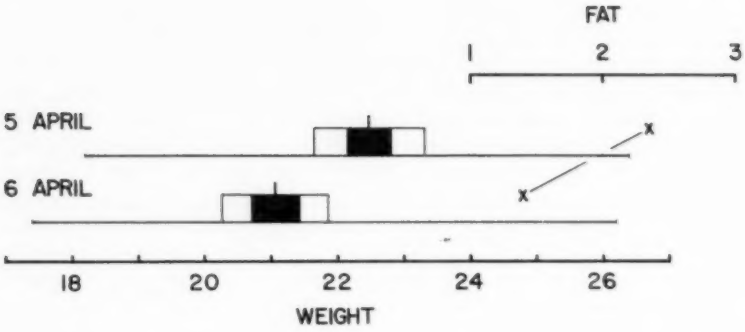

FIG. 1. Song Sparrow weight and fat before and after a night of migration. Weight data in grams (Table 1) are shown by a horizontal line representing range; an open rectangle, one standard deviation; a solid rectangle, three standard errors; and a vertical line, the mean [Mayr and Rosen (1956), based on a modification of Hubbs and Hubbs' modification of Dice and Leraas' method of graphic representation]. Non-overlap of the solid rectangles indicates a significant difference in the graphed means. For either date, mean fat is represented by an X (for explanation, see text).

Class 1 have only traces of fat on the abdomen and in the furculum, while birds in Class 2 have small visceral and abdominal deposits not forming a continuous pad. In Class 3, fat covers the abdomen but is not conspicuously mounded. In Class 4, the furculum is filled and fat on the abdomen is mounded. I have never seen Song Sparrows in our highest fat class, Class 5, in which fat in the furculum is bulging. Table 2 gives a rough comparison of our fat scheme with those of McCabe (1943) and Wolfson (1954*a*). Numbers assigned to fat conditions were averaged to arrive at figures presented in Tables 1–3 and Fig. 1.

The difference between fat on the two days is 0.95, or nearly one fat class, and may be regarded as significant.

It is clear that Song Sparrow weight and fat were higher in a migratory sample before than after a migration had occurred. Comparison of these samples with "resident," or what are actually mixed samples containing both residents and migrants (but with few data from actual pre-flight individuals; Helms and Drury, 1959), is complicated by the lack of proper seasonal data for this region.

Although Nice (1937) and Baldwin and Kendeigh (1938) list mean weights for April in a different geographical population of Song Sparrows, compari-

TABLE 2

COMPARISON OF PUBLISHED FAT CLASSIFICATIONS

Helms and Drury (1959)	McCabe (1943)	Wolfson (1954a)
0 −	No Fat	None
0 +		
1 −	Little	
1 +		Little
2 −	Moderate	
2 +		
3 −	Fat	
3 +		Medium
4 −	Very Fat	
4 +		
5 −	Excessively Fat	Heavy
5 +		

sons with these data might be instructive. Recalculating Nice's (1937) data to arrive at a mean April weight for both sexes of 21.99 grams, with an estimated standard deviation of 1.97 grams (Snedecor, 1956:37–38; considering the largest sample size of 50 given in his Table 2.2.2, p. 38, compared with this sample of 150, and the S.D. values in this paper, this point estimate is probably generous), it is possible to perform *t*-tests. These indicate that morning mean weights of the April 5 sample are significantly higher than April means ($P = .025 - .010$), and weights of the April 6 sample are significantly lower ($P = <.001$). Baldwin and Kendeigh (1938) list a mean weight of 21.4 grams for 464 adult Song Sparrows in April. Assuming that S.D. = 1.9 grams, mean weight on April 5 is significantly above the mean monthly weight ($P = <.001$), while the April 6 mean is not significantly different ($P = .20–.10$).

In connection with these comparisons, both diurnal and seasonal variation must be borne in mind. The monthly means used are based on weights throughout the day whereas means for April 5 and 6 are only morning weights. Normal diurnal weight increases would tend to increase differences between April 5 weights and the means used for comparison, while decreasing the difference between the April 6 weights and those means. Seasonal varia-

tion would, however, reverse this tendency since weights are dropping during April (Nice, 1937), and these samples were obtained near the beginning of the month. Thus, these comparisons are only indicative.

I suspect, however, that if local morning averages for the first half of April were available for comparison, April 5 weights would be significantly higher. I believe that weight and fat on this date do indeed represent a true preparation for migratory flight.

Tree Sparrow

This view is supported moreover, by data on migrant Tree Sparrows from the same migration at Plum Island, although these data are based on a much smaller sample. These are summarized in Table 3 and include only morning weights.

Table 3

Tree Sparrow Weight and Fat Before and After a Night of Migration

	Sample Size	Mean Weight	Range	S. D.	S. E.	Fat
Pre-flight Data (April 5, 1958)	7	20.13	19.0–22.5	1.20	0.45	2.86
Post-flight Data (April 6, 1958)	4	18.98	17.9–20.0	—	—	1.75

Key: See Table 1.

The difference between these mean weights, 1.15 grams, is not significant ($P = .20 - .10$), probably due to the small samples. This difference between pre-flight and post-flight individuals is, however, on the same order of magnitude as in the Song Sparrow and is certainly suggestive.

Helms and Drury (1959) do have mean weights from the same period which may be compared with these data. The mean daily weight for the first two weeks of April, 19.73 grams, is significantly below the April 5 weights (a total of 13 weights for April 5 averaged 20.61; S.D. = 1.18; S.E. = 0.33 gram; $P = .025$). Morning weights on April 6 differ insignificantly from morning means for the half-month period (19.66 grams; $P = .40 - .20$).

These statistical comparisons are free of the objections raised by the Song Sparrow comparisons, and indicate that Tree Sparrows may show a weight and fat preparation for migratory flight.

The similarity of Song and Tree Sparrow weight and fat is striking and indicates the following: (1) Energy reserves measured by body weight and visible fat are greater in these sparrows prior to a migratory flight than after. (2) These sparrows may show a true migratory preparation involving increased lipid reserves and body weight when compared with predominantly resident samples.

Discussion

Baumgartner's (1938) weight data on Tree Sparrows have been cited frequently as evidence for premigratory or migratory increases. Study of her graphed data (p. 608) compared with similar graphs in Helms and Drury (1959), and her own separation of resident and migratory periods, indicates that migratory weights are lower than the winter maximum. The heaviest samples during migration (March 15, 20–25) are significantly less than the weights of February 26 and March 4–10 during the winter peak ($P = < .001$). However, the lateness of this peak in the winter is puzzling, and it precedes migration directly. Due to the lack of temperature data and the relatively small samples, however, interpretation of this peak as premigratory seems inadvisable.

In fact, the entire picture of weight and fat variation in Tree Sparrows differs sufficiently from that of Slate-colored Juncos to warrant a brief discussion. In the former species, only two birds (in over 3000 records) have been seen with Class 5 fat. Migrant juncos, on the other hand, commonly had Class 5 fat. Differences in mean weights between successive fat classes decrease with increasing fat classes in Tree Sparrows (1.36, 0.96, 0.72 grams, respectively), and inversely in juncos (0.65, 1.42, 1.27, 1.59 grams, respectively; Fig. 3, Helms and Drury, 1959). Tree Sparrows showed no peaks in mean weights clearly associated with migration, whereas Slate-colored Juncos did.

On this basis, I propose two different patterns of weight–fat variation in emberizines. Type I variation (Slate-colored Junco) may be characterized by: (1) significant weight and fat increases evident in spring migratory periods in wild populations, if these populations are migratory; (2) heavy fat deposition (Class 5) regularly found in migrant individuals; and (3) mean weight differences between fat classes increasing with increasing fat class. The sex of birds showing this type of variation may be determined at all times of the year by the cloacal protuberance (Drost, 1938; brief discussion below). This may be contrasted with Type II variation (Tree Sparrow), characterized by: (1) insignificant weight and fat increases in grouped mean data during migratory periods in wild populations; (2) heavy fat deposition (Class 5) rarely or never found; and (3) differences in mean weights between fat classes decreasing with increasing fat class. In my experience the sex of birds in this type may be reliably determined by the cloacal protuberance only during the breeding season.

Since these patterns are based on findings in two species, it would be well to see if other emberizines fit either pattern. My own observations of captive and wild White-throated Sparrows indicate that they are typical Type I

variants. Wolfson's (1954*a*:419) data on this species verifies condition (3) of Type I if differences in our fat classifications are borne in mind, and Odum (1949) and Odum and Perkinson (1951) verify conditions (1) and (2) for this species. White-throats can be sexed at any season by the cloacal protuberance.

My observations on captive White-crowned Sparrows (*Zonotrichia leucophrys*) and Oregon Juncos (*Junco oreganus*) indicate that they also are Type I variants.

Nice's (1937, 1946) weight data suggest that Song Sparrows fit condition (1) of Type II variation. It should be noted that this condition applies to grouped mean data in wild populations and does not preclude significant weight increments in migratory individuals prior to flight as reported in this paper. My own field observations indicate that condition (2) is satisfied for this species. Although limited data on fat in Song Sparrows are available, it seems that condition (3) is also met. In the Tree Sparrow, a Type II variant, the mean weight difference between Classes 1 and 2 fat is 1.36 grams. In the Song Sparrow samples considered here, in which the fat differences are essentially those between Classes 1 and 2, the mean weight difference is 1.41 grams, in close agreement with the Tree Sparrow increment. Limited data on higher fat classes indicate mean differences do decrease, and condition (3) is fulfilled. I am unable to sex Song Sparrows in spring by the cloacal protuberance.

My field data suggest that Type II variation is also shown by Fox Sparrows (*Passerella iliaca*), Swamp Sparrows (*Melospiza georgiana*), and possibly by Savannah Sparrows (*Passerculus sandwichensis*). Data on one captive female Lark Sparrow (*Chondestes grammacus*) suggest either Type II or a third type of variation.

Whether these particular types and conditions of variation are upheld or not, it seems evident that there are at least two distinct physiological patterns of weight and fat variation in different species of emberizines.

The Cloacal Protuberance.—Since the usefulness of the cloacal protuberance in determinations of sex of non-breeding birds is frequently overlooked, and because this usefulness is different in the two variant types, a brief discussion is in order. Salt (1954) and Wolfson (1952, 1954*b*) have described the anatomy and function of the breeding protuberance. Drost (1938), after long study of the protuberance, concluded that it could be used satisfactorily to sex many non-breeding species of European birds. In general, the male protuberance, which contains paired seminal vesicles, forms a distinctly angular junction with the abdomen and has a more or less flattened tip. The female protuberance, lacking the sac-like seminal vesicles, forms a curved junction with the abdomen and has a more or less pointed tip. The male protuberance is generally larger but not consistently so (Helms, 1959 MS). When determination is questionable, the bird is usually a female. Errors are most likely in juvenile birds, and in adults following the gonadal regression into early post-nuptial molt, and in very fat birds in which the

mass of subcutaneous abdominal lipid often makes the female protuberance look angular. Plumage characters and measurements should be used to check protuberance determinations.

Sexing error in Type I variants is less than 10 per cent on first handling and can be reduced to less than one per cent with subsequent determinations. I have found also that angularity of the protuberance may be used to determine gonadal regeneration in incomplete castrates.

Although Type II variants show protuberance differences, they are not consistently reliable. Sexing error by the protuberance alone is about 40 per cent and shows no reduction with subsequent determinations. The seminal vesicles of non-reproductive Tree Sparrows are less than half as large as those of White-throated Sparrows (1.4–2.0 mgm., compared with 5.5–7.4 mgm.), are slimmer, and are more tangentially oriented to the cloaca.

It should be noted that all species mentioned have bulbous type protuberances (Wolfson, 1954*b*), with the possible exception of the Lark Sparrow, whose type is unrecorded.

I have mentioned the protuberance in this paper because of the possibility of functional indications with weight and fat variation. Condition (3) of the respective types probably has an anatomical basis in the relative amounts of fat deposited in various body areas. A study such as Odum and Perkinson's (1951) would be desirable on a Type II variant. Conditions 1 and 2 would reflect these differences if such exist. However, the development of the seminal vesicles, which are responsible for the appearance of the male protuberance, is under the control of androgens (Marshall, 1955) and may be used as a crude indicator of androgen secretion (Salt, 1954). Fat deposition is essentially different in relative distribution and amount during migratory periods (Odum and Perkinson, 1951) and under a different physiological control (Helms and Drury, 1959). It can be influenced by the sex steroids (Wagner, 1956). These facts suggest that the lower level of androgen secretion indicated by the smaller seminal vesicles of non-breeding Type II variants might influence the pattern of weight and fat variation during non-breeding periods. Therefore, different hormonal levels, timing, balances, and/or sequences during migration, coupled with different morphology of the lipid reserves, might account for the differences in variation patterns.

Summary

1. Song Sparrow and Tree Sparrow samples taken before and after a night of coastal migration show that pre-flight individuals have significantly higher body weight and fat than post-flight individuals. Weight differences before and after the flight were 1.41 grams in Song Sparrows and 1.15 grams in Tree Sparrows. Fat was one class lower after the flight.

2. Comparison of these samples with monthly or half-monthly means obtained from "mixed" populations suggest that pre-flight individuals show a true migratory preparation which is not reflected in the mean values over longer periods in these two species.

3. Two patterns of weight and fat variation in emberizines are proposed with criteria for each: Type I variation is shown by Tree Sparrows, and Type II variation by Slate-colored Juncos.

4. Determination of sex using the cloacal protuberance is possible at all

seasons in Type I variants, but only during the breeding season in Type II variants.

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HATHEWAY SCHOOL OF CONSERVATION EDUCATION, DRUMLIN FARM, SOUTH LINCOLN, MASSACHUSETTS, MARCH 14, 1959 (SUBMITTED ORIGINALLY, DECEMBER 15, 1958)

NEW LIFE MEMBER

Karl H. Maslowski, an active member of the Wilson Ornithological Society since 1934, became a Life Member this year. He lives in Cincinnati, Ohio, with his wife, three sons, and one daughter. Mr. Maslowski is a motion picture producer and lectures for the National Audubon Society. His principal interest in ornithology is motion picture studies of life histories. He has been a nature columnist for the *Cincinnati Enquirer* for 23 years, and has written popular articles (many illustrated by his fine photographs) for many magazines and special publications. He has published notes in *The Wilson Bulletin*, *The Auk*, and *Journal of Mammalogy*.

Karl is also a member of the A. O. U. and the American Society of Mammalogists, and has been a board member of the Cincinnati Society of Natural History Museum and a Trustee of the Cincinnati Zoological Society for about 10 years.

HOMING OF PURPLE MARTINS[1]

BY WILLIAM E. SOUTHERN

MANY papers dealing with homing and orientation have been published. Relatively few of these papers pertain to homing ability of passerines during the breeding season. With this in mind I conducted a series of 16 homing experiments on Purple Martins (*Progne subis*) in the summer of 1958 at the University of Michigan Biological Station, Cheboygan County, Michigan. A colony of 60 pairs of martins nested in four houses along the shore of Douglas Lake.

I trapped the martins in nylon snares, made of six-pound-test monofilament fishing line, placed at the entrances to the nests. The loop of the snare surrounded the entrance hole and was held in position by a tack. When the adult entered the nest it passed through the noose which closed around its neck. The weight of the bird kept the noose tight, thus preventing escape. The birds struggled only slightly and sometimes hung motionless until I released them. No birds were injured by the snares; all birds trapped and used in experiments survived throughout the summer. Since the females did most of the nesting tasks they entered the compartments more readily, hence only two males were captured during the summer. Only one member of a pair was used in any one trial. A different bird was used for each trial.

Birds were transported to the point of release by automobile. They were carried in closed cigar boxes, and the periods of confinement ranged from 15 minutes to 23.8 hours.

Each experimental bird was color-marked in such a manner that I could distinguish it from all other martins in the colony. However, these color markings were of little use at a distance. Therefore, I waited until I definitely saw the marked bird return to the nest compartment before I considered it as a return. I refrained from marking the flight feathers with enamel because it might have interfered with flight. The enamel was placed on the crown, rump, breast, back, throat, or crissum. Seven different colors of enamel were used. For more permanent identification a U.S. Fish and Wildlife Service numbered aluminum band was placed on one leg of each bird and a plastic color band on the other.

I wish to express my appreciation to Harrison B. Tordoff for his useful suggestions during this project, to Donald Moline and other Station personnel for aid in dispatching and observing experimental birds, and to Edmund J. Tucker of the Michigan Conservation Department for observations on one bird at the release point. The expenses of this project were met by a National Science Foundation grant.

[1] Contribution from the University of Michigan Biological Station.

Experiments

Adult martins were transported to distances ranging from 1.75 miles to 234 miles (air distance). The length of time required for returns varied greatly. In several cases the precise time of return could not be determined. Furthermore, some homing birds probably were in the vicinity of the colony for some time without returning to the nest and therefore passed unnoticed. The experimental martins were usually extremely nervous after returning and hesitated to approach the nest compartment. They closely examined the entrance before they entered.

Weather conditions during these experiments varied greatly. Birds were released during rain storms, cloudy periods, clear sunny days, clear starlit nights, and cloudy nights. Wind velocity varied from two or three mph up to 28 mph. Climatological data for the release points (obtained from the U.S. Weather Bureau or local authorities) appear in Table 1.

I released birds in various directions from the home colony. Birds were liberated north of the Straits of Mackinac, on the Wisconsin side of Lake Michigan, and in the interior of the Lower Peninsula of Michigan.

The first five martins were discharged close to the Biological Station (1.75 to 10 miles) and were apparently presented with no difficulty in homing (see Table 2). This was probably familiar territory to the birds and perhaps much of it had been covered during normal feeding activities. The longer flights probably presented a greater challenge to the birds because of the increased likelihood that they must fly over unfamiliar territory, especially from release points north and west of home.

Number 6.—Female released in Grand Rapids, Michigan, at 12:00 noon, June 28. There was a strong wind (west-southwest 15 mph). She was not seen at the Station for 25.5 hours. Possibly the bird returned sooner but was not noticed or did not enter the house.

Number 7.—Male released at 8:10 p.m., June 28 at Charlevoix, Michigan. I released the bird near the shore of Lake Michigan and within the boundaries of another martin colony. He ignored the other martins and apparently they did not respond to his presence. The male performed the usual circling and gaining of altitude. The circles increased in diameter as he gained altitude. Never did the circle extend over the lake. After a few minutes I lost sight of the bird. I was not present at the Station to record the exact time of return, but he was present at the nest at 7:00 p.m., June 29.

Number 8.—This female was released at Petoskey, Michigan, at 7:45 p.m., June 28. She was not observed at the Station that evening but was seen at 7:00 a.m. the following day. She probably returned the previous evening or night. Upon release, near Little Traverse Bay, she gained altitude, circled once and headed directly toward the Station.

TABLE 1

WEATHER DATA AT PURPLE MARTIN RELEASE POINTS IN 1958

Release Point	Bird No.	Date	Temp. (°F.) High	Temp. (°F.) Low	Precipitation (inches)	Wind Dir.	Wind Speed (mph)	Sunshine (min.)	Sky Cover (per cent)	Visibility (miles)	Remarks
Pellston	1	June 25	59*	47*	trace	SW	18–20*	—	100	—	—
Reese's Bog	2	June 25	59*	47*	trace	SW	18–20*	—	100	—	—
Riggsville	3	June 25	59*	47*	trace	SW	18–20*	—	100	—	—
Cheboygan	4 & 5	June 27	74	48	0	WNW	11–15	60	0	15	clear
Grand Rapids	6	June 28	81	59	0	WSW	12–15	—	—	15	partly cloudy
Charlevoix	7	June 28	77	60	0	SSW	4–7	—	—	20	clear
Petoskey	8	June 28	75	52	0	SSW	4–7	—	—	20	clear
Escanaba	9	July 1	73		.77	S	12–18	0	100	0–2	fog
Lena, Wis.	10	July 1	85	71	trace	WSW	20–28	—	—	10	partly cloudy
Ann Arbor	11	July 7	81	67	0	NW	12	0	100	—	cloudy, wind variable
Flint	12	July 7	79	64	.28	SW	2–5	—	100	15	fog earlier, cloudy, wind variable
Ann Arbor	13	July 8	78	63	0	NW	14	—	80	—	cloudy
Sleeper Lake	14	July 13	79	66	0	NW	8	—	30	7	—
Michelson	15	July 18	68	49	trace	W	0–2	—	—	—	clear by night
Grayling	16	July 18	66	46	trace	W	0–3	—	—	—	storm front to the north (20 miles)

* Estimates by the observer.

Table 2

Data Pertaining to 16 Homing Flights by Purple Martins in 1958

Bird No.	Sex	Nest Contents	Release Point	Mileage	Direction	Released		Returned		Maximum Time to Return
						Date	Time	Date	Time	
1	♀	eggs	Pellston	6	W	June 25	12:32 p.m.	June 25	1:20 p.m.	.8 hr.
2	♀	eggs	Reese's Bog	1.75	S	June 25	3:15 p.m.	June 25	3:37 p.m.	.3 hr.
3	♀	eggs	Riggsville	4	E	June 25	4:20 p.m.	June 25	4:31 p.m.	.2 hr.
4	♀	eggs	Cheboygan	9	ENE	June 27	1:21 p.m.	June 27	2:05 p.m.	.7 hr.
5	♀	eggs	Cheboygan	10	ENE	June 27	1:30 p.m.	June 27	3:50 p.m.*	1.5 hrs.
6	♀	eggs & young	Grand Rapids	202	SSW	June 28	12:00 noon	June 29	1:30 p.m.*	25.5 hrs.
7	♂	young	Charlevoix	32.5	WSW	June 28	8:10 p.m.	June 29	7:00 a.m.*	22.8 hrs.
8	♀	young	Petoskey	19.5	WSW	June 28	7:45 p.m.	June 29	7:00 a.m.*	23.3 hrs.
9	♀	young	Escanaba	117	NNW	July 1	1:00 p.m.	July 2	12:00 noon	23.0 hrs.
10	♀	young	Lena, Wisc.	169	WSW	July 1	4:00 p.m.	July 2	10:30 a.m.	18.5 hrs.
11	♀	young	Ann Arbor	234	SSE	July 7	10:40 p.m.	July 8	7:15 a.m.*	8.6 hrs.
12	♀	young	Flint	185	SSE	July 7	6:45 p.m.	July 8	7:15 a.m.*	12.5 hrs.
13	♀	young	Ann Arbor	234	SSE	July 8	6:50 a.m.	July 8	5:30 p.m.*	10.7 hrs.
14	♀	young	Sleeper Lake	77	NNW	July 11	9:00 p.m.	July 13*	—	—
15	♀	young	Michelson	83	S	July 18	10:30 p.m.	July 21	6:30 a.m.*	—
16	♂	young	Grayling	62	S	July 18	8:05 p.m.	July 21*	—	—

* Perhaps returned earlier but not recorded.

Number 9.—This female was released at Escanaba in the Upper Peninsula of Michigan at 1:00 p.m., July 1. She remained in the area until 3:35 p. m. (observed by E. J. Tucker). This delay in departure was probably brought about by the locality being blanketed with fog. She had definitely returned and entered the house by noon on July 2. However, I thought I saw her at 7:15 p.m. on July 1.

Number 10.—Female released in Lena, Wisconsin, at 4:00 p.m. on July 1. She performed the usual circling behavior upon release and gained altitude. Perhaps this bird encountered fog when she neared Lake Michigan. She returned to the nest at 10:30 a.m., July 2. I believe that she had just returned from the homing flight since she seemed fatigued and unsteady. She landed on the perch outside the nest, wobbled back and forth, and finally fell. She caught herself on another perch located about 10 inches below. There she perched and continued to wobble about. At 12:30 p.m. she acted more stable but still did not seem completely normal. Later in the afternoon she appeared much stronger. It would be interesting to know the direction taken by this bird upon reaching the Wisconsin shore of Lake Michigan. Did she follow the shore line or did she fly directly across?

Number 11.—Female released in Ann Arbor at 10:40 p.m., July 7. She had returned to the Station and was feeding young at 7:15 a.m., July 8. From her behavior, I am certain that she had been in the area for some time. As mentioned earlier, the birds always seemed suspicious after returning from a homing flight. When I first saw this bird she did not hesitate in the least before entering the nest compartment.

She made the flight of 234 miles in no more than 8.6 hours. This is an average speed of 27.2 mph. To have established this average the martin must have exceeded this speed considerably at times, especially if she wandered in search of landmarks. However, this rate of return seems to exclude much wandering. Meinertzhagen (1921:230) had comparable results with Barn Swallows (*Hirundo rustica*). He conducted experiments in East Africa, and one bird averaged 37.75 mph, and another 34 mph. His record of an earlier flight of a swallow from Paris to Roubaix at a speed of 106 mph is open to doubt, as he pointed out. Rüppell (in Matthews, 1955:41) also conducted experiments with Barn Swallows. His birds averaged only 9 to 10 mph in homing. There are records of non-passerine species homing at rates of 8 to 37 mph.

Most interesting is the fact that Number 11 made a nocturnal homing flight. Supposedly, Purple Martins are diurnal migrants and therefore, as discussed by Lakhovsky (in Mattingley, 1946:513), should not be capable of nocturnal orientation. The fact that martins may occasionally migrate by night is suggested by Trautman's statement (1940:307) referring to a flock of 150 birds that arrived in his area in the early afternoon and left at dark. He referred to

this as "a rather curious performance for these supposedly day migrants." Many observers, including the Andersons (1946:140–141), Cater (1944:15–18), Higman (1944:43–44), and Woodbury (1946:42), have reported large flocks of martins preparing to roost for the night. Estimates of up to 25,000 martins have been given for such roosts. None of these observers mentions checking on these flocks at night to see if the birds were still present. Smith (1908:41–43) watched a diurnal migratory flight of more than 10,000 Purple Martins at Macatawa, Michigan.

Since the sky was entirely overcast (a second cloud layer being above the first), it seems unlikely that celestial navigation was possible.

Number 12.—Female released in Flint, Michigan, at 6:45 p.m., July 7. Upon release she flew south one block and then headed northwest. She had returned to the Station by 7:15 a.m., July 8. This bird probably returned earlier because she had lost all suspicion of the nest site. Part of this flight must have been performed at night.

Number 13.—Female released in Ann Arbor, Michigan, at 6:50 a.m., July 8. This bird had been captive in a darkened container for 23.8 hours. She returned to the Biological Station sometime during the afternoon of July 8. I was prevented from checking on the return until 5:30 p.m., and she was present at that time. Apparently she made this return flight in a time comparable to bird Number 11.

Number 14.—Female released at Sleeper Lake, Luce County, in the Upper Peninsula of Michigan at 9:00 p.m., July 11. She circled clockwise and then counter clockwise while gaining altitude and then headed southeast. I did not see her at the Station until the afternoon of July 13, although I made periodical checks during each day of her absence.

Number 15.—Female released at Michelson, Roscommon County, Michigan, at 10:30 p.m. on July 18. At the release point the sky was clear of clouds, and there was little wind. A storm center lay between the bird and home at the time of release. She did not return until 6:30 a.m. on July 21.

Number 16.—Male released at Grayling, Michigan, at 8:05 p.m., July 18. He circled high for about ten minutes before I lost sight of him. He was confronted with the same storm center as bird Number 15. I failed to note him at the Station until 6:30 a.m., July 21.

Discussion

To my knowledge this was the first time Purple Martins were used in homing experiments. Other members of the Hirundinidae have been used. These include the Bank Swallow (*Riparia riparia*), Rough-winged Swallow (*Stelgidopteryx ruficollis*), Barn Swallow, and the House Martin (*Delichon urbica*). These species have homed in trials ranging from four miles to the amazing

distance of 1150 miles (see Table 3). The percentage of returns has varied greatly. Rarely did investigators that used more than four birds find a return rate higher than 50 per cent. It is therefore of interest to note that all 16, or 100 per cent, of my Purple Martins returned from the point of release.

TABLE 3

HOMING DATA PERTAINING TO THE HIRUNDINIDAE

Species	Trials	Returns	Per Cent Returned	Distances (miles)	Sources
Bank Swallow	35	13	37	4–142	Loos (1907), Matthews (1955)
Rough-winged Swallow	3	3	100	4–33	Gillespie (1934)
Barn Swallow	198	92	47	4–1150	Dupond (1935), Keller (1926), Lack (1938), Lockley (1942), Loos (1907), Rüppell (1934, '35, '36, '38), Wodzicki (1934, '38, '39), Wojtusiak (1937)
Purple Martin	16	16	100	1.75–234	Southern (present study)
House Martin	35	12	34	7–450	Matthews (1955), Rüppell (*op. cit.*), Wodzicki (1934)

SUMMARY

During the summer of 1958, 16 Purple Martins were used in a series of homing experiments at the University of Michigan Biological Station.

The birds were released at distances ranging from 1.75 miles to 234 miles. The rate of return varied greatly. The most rapid return was a nocturnal flight of 234 miles in 8.58 hours.

One hundred per cent of the martins returned from the homing flights. This material has been compared with the available homing data pertaining to the Hirundinidae.

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THE DEVELOPMENT OF SOUND-SIGNAL PREFERENCES IN DUCKS

BY PETER H. KLOPFER

In an attempt to analyze one aspect of the ontogeny of behavior, a study was made of the manner in which young ducks and geese developed response tendencies directed toward specific sound-signals (Klopfer, 1957, and in press). It was found that the surface-nesting species which were studied (principally Mallards, *Anas platyrhynchos*, and Redheads, *Aythya americana*), if reared under conditions of relative auditory isolation, tended to approach most rhythmic, repetitive signals without discrimination. This behavior was not altered by intermittently exposing the birds to recordings of a particular signal at different ages before and after hatching. A specific response could be established, however, by presenting the sound while the bird was following a moving model or the experimenter. In at least one hole-nesting species, the Wood Duck (*Aix sponsa*), a different pattern was obtained. This species showed no tendency to approach rhythmic signals when the individuals tested were reared as auditory isolates, and this was also true for the birds which had been exposed to the moving experimenter plus a sound. Those birds which had been exposed to the sound alone, however, very rapidly developed a tendency to approach that sound to the exclusion of others. Individuals of a domestic strain of Muscovy Duck (*Cairina moschata*), which were largely nonvocal, could not be made to approach the sound signals irrespective of the treatment accorded. In all these instances the manner in which responses to auditory signals are established is related in a fairly simple way to the nesting habits and social organization of the different species. Of course, such a correlation does not in itself shed light on the causal relations, e.g., evolutionary development, of the traits in question.

In the present study I was concerned to re-examine one of the hypotheses of my previous work (*ibid.*). In particular, I wished to know whether the type of auditory imprinting shown by the Wood Duck would be shared by other hole-nesting species which are not members of the tribe Cairinini (Delacour and Mayr, 1945). For these purposes the Common Sheldrake (*Tadorna tadorna*, tribe Tadornini) was selected, for it was reasonably abundant locally and habitually nests in deep rabbit burrows.

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Methods

The birds were arbitrarily distributed among three training groups which were treated as follows:

Isolates—Fifteen birds were incubated and hatched in an incubator situated within a sound-proof room (Thorpe and Hinde, 1956). These ducklings were kept in groups of 3 to 5 and heard no sounds other than those they themselves produced until the time at which testing took place, when the birds were between 18 and 26 hours of age.

Sound Only—Ten birds, from the moment of emergence until 10 to 14 hours of age, were exposed to a recorded sound-signal of three minutes' duration at intervals of one to two hours. The total time of exposure was 30 minutes. Each bird was exposed to one of two possible sounds: a slowly repeated monosyllabic *kom kom kom* or a more rapid and higher *pip pip pip*. Audiospectrographic analysis had previously shown that these two calls roughly resembled the two principal types of calls made by females of several tribes when leading young (Klopfer, 1957). These birds were tested 8 to 12 hours after the last exposure.

Following with Sound—Ten birds were allowed to follow the experimenter as soon as they proved able to walk, which was generally between 6 and 10 hours after emergence. At the same time they were exposed to one of the two sounds described above. Originally it was intended to have these birds follow a loudspeaker and model which were suspended from a pulley system, but the birds all proved to follow far more satisfactorily an articulated object such as the experimenter. Each following exercise took 5 to 10 minutes, with a maximum total of 30 minutes of exposure. A few good followers were exposed for only 20 minutes. Testing took place after an interval of 8 to 12 hours after the last exposure.

For the tests, the birds were individually introduced into a four-foot square box from each corner of which a smaller $6 \times 6 \times 12$-inch box radiated. Each of the latter boxes had an opaque cover and, at the outer end, a loudspeaker. The central box had a black gauze cover so that, when lighted from within and placed in a darkened room, it was possible to observe the birds within without their being aware of the observer's presence. Sixty seconds after a bird had been introduced into the center of this apparatus, during which time it either sat quietly where it was placed or else wandered slowly about the central box, a sound signal was played through one of the speakers and the response of the bird noted. Although, on the basis of my earlier work, different types of responses were expected, the sheldrakes either went to the source of the sound within two minutes of its onset (and usually within 30 seconds, alternately emitting pleasure and distress notes, then entering the small box and pecking against its sides), or else they continued as they had been prior to the onset of the sound signal. In a few instances, the bird scurried quietly into one of

the boxes away from the sound source and crouched in a corner. This occurred a similar number of times before the onset of the sound signal. Whenever a bird had entered a small box, it was removed and replaced in the center of tht apparatus before the next signal was presented.

The order in which the sounds were presented was systematically varied, as was the direction from which the sounds originated.

In addition to the sound signals described above, *kom* and *pip*, a disyllabic, slowly repeated *hel-lo* was also used, the pitch falling sharply from the first to the second syllable. This sound crudely mimics some of the more complex notes of male Wood Ducks, and species with similar whistled notes.

The previous experiments had demonstrated that during the period of a 30-minute test, changes in responsiveness were generally slight, as were the effects of experiences within the test apparatus. At that time, birds had been tested with a number of different sound-signals, including recordings of certain of the calls of various species of ducks and geese. In this instance, the lower temperatures which prevailed called for a significant reduction in the duration and number of the tests. As a consequence, the interpretation of the data must be qualified in certain ways (see below).

Ages were arbitrarily designated to be the number of hours elapsed from the moment of total emergence from the shell. This procedure is undoubtedly responsible for a certain amount of variability in the behavior of ducklings allegedly of similar ages, for the interval between the emergence of the first and last bird from a group of eggs incubated together was as great as 30 hours. As the eggs were collected before incubation had commenced and were then held at 40° F. for one to three weeks before being placed in the incubator, the actual developmental age of the first and last birds in such a hatch must differ widely, even though, one hour after emergence, both are considered to be "one hour old." Probably the temporal limits of the critical period for imprinting would be altered by an appropriate adjustment of the post-hatching age. Therefore, it would seem wise in the future for researchers to report with more precision the exact ages of ducklings under study.

Results and Discussion

The general impression given by the 24-hour-old sheldrakes was that they were considerably less vocal than young Mallards, Redheads, and Wood Ducks. While these birds generally replied to the introduced sound-signals by emitting pleasure or distress notes, the sheldrakes did so far less frequently, and they did not appear to chatter among themselves so much. The fear response shown by isolates of 24 hours of age when first handled was also pronouncedly less severe than in these other species. It should be remarked that all of the sheldrakes used in these experiments required assistance in breaking through

the shell—possibly because the relative humidity within the incubator was not sufficiently high to prevent toughening and adhesion of the shell membranes. However, those birds which did survive appeared to be normally vigorous, and this assistance probably did not affect their behavior appreciably. Similar help had been given some of the birds from the earlier experiments, and apparently they did not differ from their normally-hatched siblings.

Of 88 freshly collected eggs, 19 were infertile, 8 contained dead embryos before 25 days of incubation, 19 embryos died after 25 days, and 6 hatched with severe intestinal prolapses. The results of trials with 35 of the remaining birds may be seen in Table 1.

TABLE 1

SOUND-SIGNAL RESPONSES OF 35 COMMON SHELDRAKE DUCKLINGS

Training Group	No. of Ducklings	Proportion of Ducklings Responding to Sound-signals			
		Kom	Hol-lo	Pip	Total
Isolates	15	none	1/15	1/15	2/15
Sound Only	10	0/7		2/3[1]	2/10[1]
Following with Sound	10	1/6[1]		4/4[1]	5/10[1]

[1] Responded exclusively to sound to which they had been exposed.

It is more than moderately frustrating that the high mortality reduced the sample to a level where simple tests for significance cannot be applied. Certain comparisons with earlier data are possible, however. In the case of the Isolates among the Wood Ducks and Muscovy Ducks, 3/12 and 1/12, respectively, responded to one of the three sound signals (in addition to others), while among the surface-nesting ducks 12/12 responded. The confidence limits of these proportions do not overlap at the .05 level. Thus, it can be said that the sheldrakes, like the Cairinini studied, have no tendency to approach all rhythmic signals. The possibility that their responses are simply attuned to a narrower spectrum of sound, of course, cannot be eliminated, especially since so few test signals were used. But the difference from the surface-nesting birds remains.

Only 3/24 of the surface-nesters which had been members of the Sound Only group developed a specific response tendency directed exclusively toward the relevant signal, while the corresponding proportion for the Wood Ducks is 13/24. These proportions differ significantly at the .05 level. For the nonvocal Muscovy Ducks it is 0/18. The proportion for the sheldrakes is 2/10. In their seeming insusceptibility to auditory imprinting, the sheldrakes appear more like the other species than the Wood Duck.

Finally, in the Following with Sound group, 1/19 Muscovy Ducks, 1/24 Wood Ducks, but 16/25 surface-nesters developed a specific preference for the

relevant sound signal. Of the sheldrakes of this group 5/10 did the same, but it is striking that all five birds which were actually following the experimenter during the brief periods of exposure showed an extremely marked response to the relevant sound signals, and to these alone. Thus, while we cannot exclude the possibility that other sounds exist to which these birds would respond in the absence of visual and motor experience, it does appear that a preference can be established for sounds which are linked to a visual model. As in the surface-nesters, we may surmise that the following-response serves as a necessary reinforcement in the learning of particular sound-signals. This is decidedly not the pattern which was predicted for hole-nesting species, for whom auditory stimuli should be of greater importance than visual ones, and who should be either endowed with response tendencies directed to specific auditory stimuli at the time of hatching or else highly susceptible to auditory imprinting. This latter, for instance, seems to be true of the Wood Duck. We might thus suspect that newly hatched sheldrakes emerge from their burrows in response to visual or perhaps tactile stimuli, with auditory cues assuming a secondary importance.

Summary

Thirty-five incubator-hatched Common Sheldrake (*Tadorna tadorna*) ducklings were tested for determination of type and degree of auditory imprinting. Fifteen of them were isolated in a sound-proof room where they heard no extraneous sounds. These showed little tendency to approach repetitive sound-signals. In this respect they were similar to Wood Ducks (*Aix sponsa*), and Muscovy Ducks (*Cairina moschata*), and unlike many species of surface-nesting waterfowl. Ten others of the young ducklings were exposed intermittently to recorded sound-signals which produced no change in their response patterns and in this respect sheldrakes were unlike Wood Ducks. Ten others were allowed to follow the experimenter while being exposed to the sound-signals. A highly specific preference for the sound was evident. This behavior was characteristic of several species of surface-nesting waterfowl.

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SOME FUNCTIONS OF THE RECTRICES AND THEIR COVERTS IN THE LANDING OF PIGEONS

BY HARVEY I. FISHER

THE tails of birds are used in many ways; at least, observational data have led to several postulated functions. This study is concerned with two of these—the tail as a supporting surface for part of the body weight, and the tail as an air-brake. Observations under field conditions have indicated to many workers, including the present one (1946:625), that the tail is frequently of major importance as a supporting surface and a balancing mechanism in flight. Further, depression of the tail just before the impact of landing indicates its probable use as a braking air-foil to slow forward motion.

Unfortunately, there has been no definite experimental evidence to support these hypotheses of function; and this information is virtually impossible to obtain under field conditions. Therefore, resort was taken to the experimental conditions used in previous studies (Fisher, 1956a, 1956b, 1957, 1958). Function of the tail in landing forms the basis of this study because the effects of experimental procedures can be measured.

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I wish to express my appreciation to Dr. Lawrence Bartlett of the University of Massachusetts for his help with the initial experiments in the spring and summer of 1956. My thanks also go to the Graduate School of Southern Illinois University for its financial support of my continuing studies in the functional anatomy of birds.

METHODS

Pigeons (*Columba livia*) were trained to fly through a cloth tunnel and to land on an apparatus capable of measuring the three vectors of force involved in landing.

The forces of landing were measured in groups of 100 landings made at weekly intervals. The control series (300 landings) was made first, and then successive series of 300 landings were made after each successive removal of feathers.

There were two patterns of removal of rectrices: 1) removal of the inner two rectrices on each side, followed by removal of the two next most medial ones, and finally elimination of all rectrices; and 2) removal of the two outermost rectrices on each side, followed by the two next outermost, and then all remaining tail feathers. As a last experimental act in each of the two procedures described, all tail coverts were taken off. In each instance the feathers were eliminated by clipping them next to the skin, using scissors. Replacement feathers were similarly eradicated in the few instances of their occurrence.

Thus, for each of the eight pigeons used (four for each of the two patterns of sequential removal of rectrices) there were 15 sets of data, obtained over a

period of 15 weeks, as follows: 300 control landings, 300 landings with four tail feathers off, 300 with eight rectrices removed, 300 with all tail feathers gone, and, finally, 300 landings of each bird with all rectrices and tail coverts removed.

The numerical data obtained were analyzed in several ways: 1) change during the 100 landings on any one day (Figs. 1 and 2); 2) change between consecutive weeks of the same series, that is, change within any one group such as the control landings; and 3) change between the different experimental and control series (Tables 1 and 2). In these analyses, comparison was made on the basis of averages of successive sets of 20 landings, of the 100 landings each week, of the first 100 landings after each experimental procedure, and averages of the 300 landings in each series.

TABLE 1

AVERAGE FORWARD (BRAKING) FORCES OF LANDING BEFORE AND AFTER REMOVAL OF TAIL FEATHERS[1]

	Removal progressive from inner to outer				Removal progressive from outer to inner			
Series	No. 106	107	109	111	No. 108	110	112	114
controls	13.2[2]	12.1	11.4	11.9	9.8	9.3	10.1	9.9
4 rectrices off	13.5	12.0	12.6	12.8	9.5	7.5	9.6	9.8
8 rectrices off	10.6	10.1	10.7	11.8	7.5	8.1	9.0	8.3
all rectrices off	11.5	11.5	10.4	11.0	8.3	7.5	8.5	8.6
tail coverts off	11.9	11.2	11.0	11.8	6.6	—	7.7	7.8

[1] Each average is of a total of 300 landings made on three successive weeks following feather removal.
[2] Forces are in millimeters of deflection. For conversion to grams see Fisher (1956b:338).

TABLE 2

AVERAGE DOWNWARD FORCES OF LANDING BEFORE AND AFTER REMOVAL OF TAIL FEATHERS[1]

	Removal progressive from inner to outer				Removal progressive from outer to inner			
Series	No. 106	107	109	111	No. 108	110	112	114
controls	10.6	10.9	10.7	11.0	9.4	9.3	9.9	8.9
4 rectrices off	11.9	12.0	12.6	12.1	9.6	7.5	9.7	9.0
8 rectrices off	10.3	10.5	12.0	11.5	9.4	8.1	8.6	9.3
all rectrices off	10.8	10.9	12.7	11.7	10.3	7.6	9.5	10.2
tail coverts off	11.8	12.3	12.0	12.2	10.1[2]	—	9.8	9.9

[1] See footnotes to Table 1.
[2] Only 240 landings; bird refused to land more than 40 times on first day.

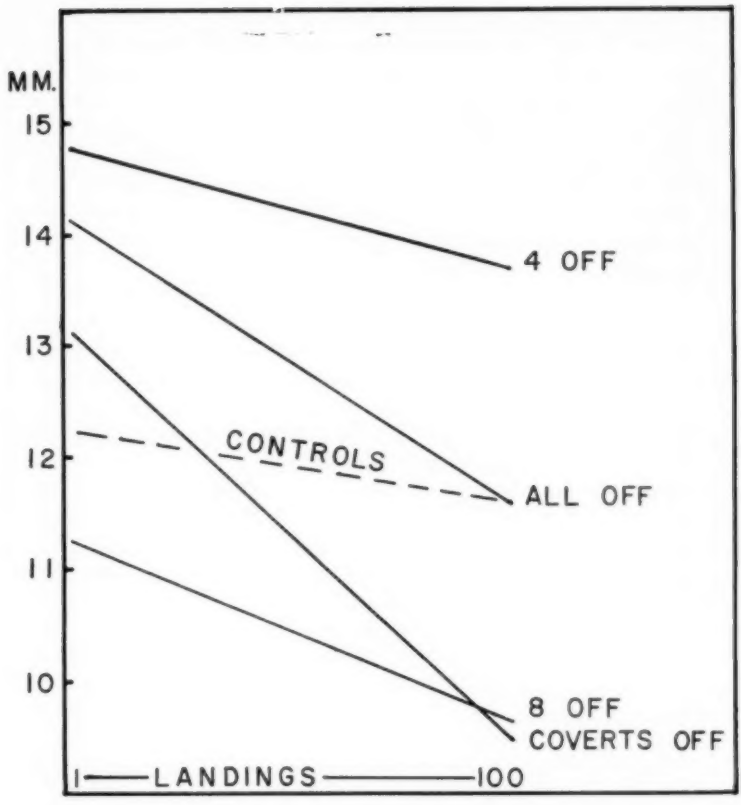

FIG. 1. Changes in braking force of landing of pigeon no. 107, with successive removal of tail feathers. Each line represents the averages of the first 20 and the last 20 landings on the first day of each series.

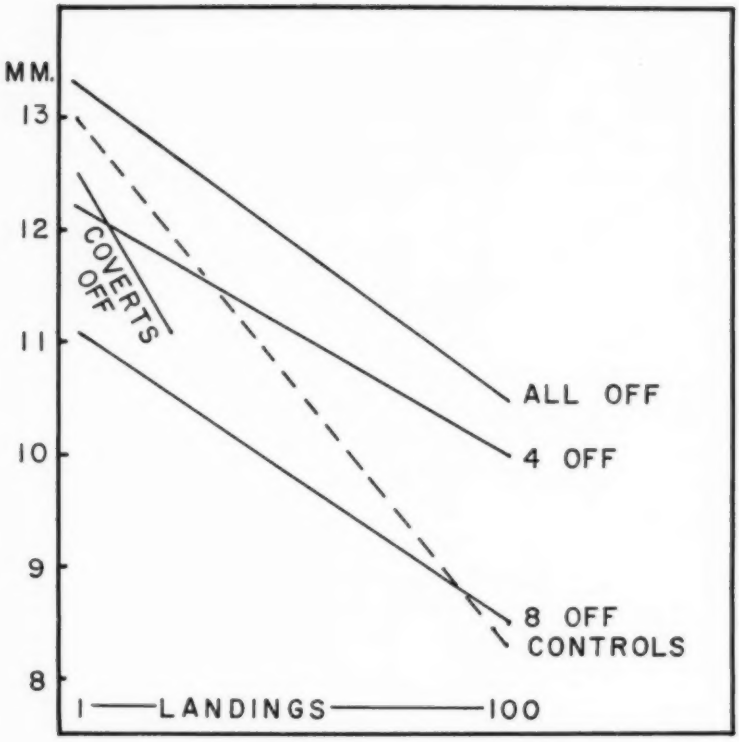

FIG. 2. Changes in downward force of landing of pigeon no. 108, with successive removal of tail feathers. Each line represents the averages of the first 20 and the last 20 landings on the first day of each series.

Results and Discussion

In most instances the various pigeons demonstrated the "learning to land" phenomenon postulated by Fisher (1956a). As before, this learning was observed within the 100 trials of each day (Figs. 1 and 2) and between consecutive weeks of each control and each experimental series.

In the analysis of successive trials it must be remembered, then, that a progressive decrease in forces would be expected. This decrease could be anticipated between the various experimental series. Thus, even in those instances where forces did not change, the very lack of change may be significant.

When feathers are removed from the center of an air-foil such as the tail, the surface area is not only decreased, it is broken into two foils. Each foil has turbulence along either edge and across its end; the increased turbulence reduces the effectiveness of the foil. Removal of feathers from either side of the tail reduces the area of the foil but probably does not materially affect the turbulence.

Under normal conditions the coverts probably do not directly affect either area or turbulence, but after removal of the rectrices the projecting coverts form an air-foil and affect both supporting area and amount of turbulence.

Successive removal of rectrices from medial to lateral.—Taking off the four central rectrices caused a major increase in both the braking and downward vectors, but the effect was greatest on the braking force (Tables 1 and 2, Figs. 1 and 2). Nevertheless, both forces decreased during the 300 trials, as the pigeons learned to land with their new tail-foil. Removal of four additional central rectrices did not interrupt this learning, and forces continued to decrease. However, when all the rectrices were taken away a new situation was presented, and the forces either increased or decreased only insignificantly. With expected learning, decreases should have occurred.

In these birds, removal of the coverts increased the initial forces of landing or at least prevented anticipated decreases (Tables 1 and 2), but, as exemplified by pigeon no. 107 (Fig. 1), the birds learned to land very lightly by the end of the first 100 trials after the coverts were clipped.

It was apparent in these four pigeons that the downward vector was affected more than the braking vector.

Successive removal of rectrices from lateral to medial.—This sequence of removal did not disrupt the previously established patterns of forces as much as removal from medial to lateral. This was expected.

Braking forces decreased at approximately the same rate as in previous experiments, except for the series of birds with four lateral rectrices off and with all rectrices off. These latter decreases were less.

Downward vectors of force exhibited no significant changes on the basis of averages (Table 2) and this indicated a loss of effectiveness in supporting

the body weight. It may be observed in Fig. 2 that the typical bird showed decreased downward forces during the first 100 trials after each removal. Nevertheless, all final trials had these forces as great or greater than the forces during the control landings.

Another phenomenon associated with removal of all rectrices and with removal of coverts was observed in three of the eight pigeons. Pigeon no. 106 was very hesitant to fly and land after covert-removal; many unsuccessful attempts were made. Pigeon no. 108 refused to fly and land more than 60 times immediately after covert removal; this same pigeon was "difficult" after all the rectrices were taken off. No. 110 never would perform properly after the coverts were eliminated. These three birds were well trained, and there had been no "reluctance" in prior landings. It is my feeling that these pigeons may not have performed because the tail was so ineffective.

In six pigeons Fisher (1956a: 95, Fig. 6) noted, during the first 100 trials, that downward force was greater in terms of millimeters of deflection than forward (braking) force and that the latter was more variable. In the four pigeons of this study in which removal of rectrices started medially, braking force exceeded down force in the first 600 landings and the two forces were approximately the same at the end of all experiments. In the four pigeons from which removal of lateral rectrices was first, the two forces were nearly equal initially, but downward force was much greater by the time the entire tail and coverts were removed, but only because braking forces decreased. The comparisons of the controls of this and the previous study indicate individual variation, of course, but the differences between the control series of 1956 and the present experimental ones are significant in their support of several opinions expressed above concerning the disruption, by the experimental procedure, of the decreases in forces that might be expected to result from learning. For example, only in the braking forces of pigeons subjected to removal of rectrices from lateral to medial is there consistency with the postulated pattern of decrease with learning.

Summary

Evidence is presented to show that the tail, in domestic pigeons, is used both as a mechanism for slowing forward motion (braking) just prior to landing and as part of the surface to support the weight of the bird.

Obviously the removal of rectrices, medially or laterally, reduces the supporting area; this would be expected to increase the downward vectors of force at the time of landing. However, the pigeon can compensate in some manner to hold these forces down to the control level. Removal of medial rectrices, because it forms two air-foils, with attendant increases in turbulence, where only one existed before, causes a greater increase in the downward vec-

tors. When the rectrices are removed in sequence from outermost to innermost, removal finally of the coverts causes no great increase; when the removal starts medially, taking off the coverts as a last procedure results in significant increases in downward vectors. In the latter instance the coverts form an important part of the functioning air-foil, replacing in part the absent medial rectrices.

The braking functions of the tail were less disturbed by removal of rectrices, probably because it is easier for the bird to compensate by varying its landing speed, its rate of wing-beat, and its angle of inclination at the moment of landing. Progressive removal from lateral to medial results in a pattern of braking forces not different from the patterns of decrease exhibited by control birds over comparable lengths of time. In other words, there is nearly complete compensation by the pigeons.

When medial rectrices are taken off first, the bird cannot compensate so completely for the effects of added turbulence and the decreased surface of the resulting double air-foil. In some pigeons little compensation, as indicated by little if any decrease in braking forces during the experiments, occurs. This breakup of the expected pattern of decrease reveals the use of the tail as an air-brake.

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Department of Zoology, Southern Illinois University, Carbondale, Illinois, February 16, 1958

GENERAL NOTES

Tarsal scutellation of song birds as a taxonomic character.—In arranging the shrikes (*Laniidae*) for a forthcoming volume of Peters' "Check-list," I found it necessary to evaluate the type of scutellation on the back of the tarsus as a taxonomic character. This quickly led beyond the shrikes and their near allies, to a hasty survey of the tarsal covering and its scutellation in all the oscine or song bird families.

Of necessity the dried feet of museum specimen skins were used, and distortion due to drying may have obscured certain points. However, some aspects of tarsal scutellation as an indicator of relationship did emerge.

The larks (*Alaudidae*) are distinctive in having a latiplantar tarsus. That is, the tarsus is rounded posteriorly and the covering of the front is separated from the scutellate covering of the back by a narrow groove on the inner side of the tarsus. This sets them off from the rest of the oscines and they are not considered further.

The tarsal envelope of the song birds, exclusive of the larks, is characterized by a single series of scutes, or a single plate, presumably of fused scutes (the booted condition) covering the front of the tarsus (the acrotarsium); a pair of plates, one on each side, covering the posterior or plantar part of the tarsus and being in contact with the acrotarsium in front, and meeting behind to form a ridge. This gives the diagnostic triangular cross section of the song-bird tarsus called acutiplantar.

There are modifications of this condition. The booted condition may not be complete, a few scutes being present at the distal end of the acrotarsium, or there may be obscure lines indicating nearly obliterated scutes along its length. On the plantar surface the "heel" and an area on the distal end of the tarsus are covered with skin that may be more or less rugose, papillose or even furnished with small scutes. These areas of skin may vary in extent and extend a short distance between the plantar plates and rarely may even meet, completely separating the plates.

A less common condition is for the outer surface of the plantar aspect of the tarsus to be scutellate. Sometimes these scutes are fairly regular. Sometimes they decrease in size distally and irregularly, and this condition is usually associated with lack of fusion between the elements. Then areas of skin, that may be rugose or papillose or carry small scutes, may be conspicuous between the inner plantar plate and the outer scutes, or even between the scutes. The least common condition is to have the inner plantar surface broken up into scutes. Despite the acutiplantar shape of the cross-section of the tarsus, the name taxaspidian might be applied to these plantar-scutellate tarsi, which are very similar to those in the non-oscine passerine family, Rhinocryptidae, of South America.

As one might expect, intermediate types occur, and also individual variation exists, making any finely divided and ironclad classification impractical.

However, the distribution among song bird groups of some clear-cut examples of each of the three main types, booted-laminiplantar, scutellate-laminiplantar, and scutellate-scutellate plantar, and the further modifications of the separation or fusion of the plantar scutes or plates, is illuminating.

The scutellate-laminiplantar condition predominates in most families of song birds, from cuckoo-shrikes (Campephagidae) to sparrows (Fringillidae) in Wetmore's arrangement.

The booted tarsus, always accompanied by the pair of plates on the plantar surface, predominates in the Turdidae (restricted sense), but also appears commonly in the related flycatchers (Muscicapidae, restricted sense). This booted condition also occurs occasionally elsewhere in widely separated groups, for example in Corvidae (*Pyrrhocorax* = *Coracia*), Timaliidae (*Orthonyx*), Sittidae (*Rhabdornis*), Meliphagidae (*Melipotes*), and

it is approached at least in some members of such groups as Paradiseidae, Cracticidae, Callaeidae, and Mimidae. Occasionally, perhaps as individual variation, the booted condition appears in Parulidae (*Peucedramus*, *Chamaethlypis*).

The scutellate outer plantar surface is a less common condition and characterizes no one group held together by other characters. Regular scutes on the outer plantar surface are present in some Laniidae (*Eurocephalus*, *Lanius* [part]), some Bombycillidae (*Hypocolius*, variable in *Ptilogonys*); and less regular scutes are present in some members of Corvidae (*Corvus*), Sturnidae (*Mino*, *Galeospar*), Oriolidae (*Sphecotheres*), Laniidae (*Lanioturdus*, *Nilaus*, *Prionops* [obscure, variable], *Tchagra* [part, variable]), and Ptilonorhynchidae (*Scenopoeetes*), and may be obscurely indicated in such diverse groups as Campephagidae (*Tephrodornis*) and Troglodytidae (*Salpinctes*), and occasionally as a single division of the plantar plate in many others.

The scutellate condition of the inner plantar surface does not always agree with that of the outer plantar surface, and seems equally variable. In the Laniidae, subfamily Prionopinae (helmet shrikes), the inner plantar scutellation is regular and compares well with that of the outer in *Eurocephalus*. However, in *Prionops*, in which the outer plantar scutellation is variable, that on the inner surface is still more so. In *P. retzii*, the only species in which I found inner plantar scutellation regularly, it occurred only about half the time. I did not find it in *P. plumata* (in which outer plantar scutellation is obscure, incomplete or absent), nor in the very similar *P. poliolopha* (outer surface obscurely to distinctly scutellate), nor the more different *P. caniceps* (outer surface not scutellate).

In the Malaconotinae (bush shrikes) *Nilaus* has the inner and outer plantar surfaces regularly scutellate; *Lanioturdus* (monotypic) may have them non-scutellate (i.e. laminar) or irregularly scutellate; in *Tchagra* I found no inner plantar scutellation though in some species, i.e., *T. cruentus*, the outer surface was regularly scutellate as an individual variant.

In Laniinae (typical shrikes) the outer plantar surface may or may not be scutellate, but I did not find it so on the inner.

A scutellate inner plantar surface also occurs in the Ploceidae, (weaver birds), in the genus *Bubalornis*.

The separated condition of the plantar plates or plates and scutes along the posterior mid-line occurs occasionally in such diverse groups as Laniidae (*Lanioturdus* [individual variation]), Vangidae (part: *Falculea*, distinct papillose skin, 1 specimen; *Leptopterus*, indistinct, 1 specimen), Sturnidae (part: *Mino*, distinct), Oriolidae (part: *Sphecotheres*, 2 lines of small scutes), Ptilonorhynchidae (part: *Scenopoeetes*, 2 lines of small scutes), Corvidae (part: *Corvus corax*, in which separation of plantar scutes from acrotarsium may be pronounced), and this condition is probably approached in many others.

Presumably a primitive condition of the song bird tarsus was to have the front of the tarsus scutellate and the back covered with numerous small scutella or granules (pycnaspidean condition) as seen today in some members of the family Cotingidae. From this the scutella on the back enlarged and coalesced into two plates and the frontal scutes coalesced, and the whole form a well fused, booted tarsal envelope, the most advanced condition.

On the other hand, part of the problem in deciding on relationships in the oscines is that there are really no primitive song birds. They are, so to speak, not twigs but leaves on the top of a postulated phylogenetic tree. So many other characters seem to appear and disappear sporadically (in shape of bill, color pattern, etc.) throughout the group that it comes as no surprise to find the same to be true of the types of tarsal scutellation.

That the condition of the tarsal scutellation is adaptive seems doubtful. We find the booted tarsus in semiterrestrial thrushes, arboreal honeyeaters of the twigs, and creepers of

the tree trunks. We find booted tarsi on slender-footed thrushes and a coarse-footed Timaliidae; on large choughs and small chats.

From the sporadic occurrence of various types of scutellation among song birds, and the individual variation they sometimes exhibit, the conclusion seems inescapable that the pattern of scutellation of the tarsal envelope is of limited importance as a character indicating relationships within the oscines, once the larks, Alaudidae, are excepted, nor will it separate oscines from nonoscines in all cases. The three main types of scutellation occur in one family (Corvidae). Even when a booted tarsus predominates in a family (as Turdidae, restricted sense), it does not separate its members from some of its near relatives (as the Muscicapidae), nor does its lack in other groups (as Sylviidae) preclude associating them with it (as in the family Muscicapidae in a comprehensive sense).

The well-defined scutellate plantar surface and the separation of the inner and outer plantar plates or scutes is a condition that occurs in obviously distantly related species. Individual variation in a species is such that the type of plantar scutellation may not even be a specific character.

One generalization that emerged from this survey was that the tarsal scutellation of the nine-primaried New World oscines is less variable than that of the Old World groups. Neither the extremes of the booted condition, nor of the scutellation of the plantar surface occurs in a well defined condition in the vireos to finches and their allies, which presumably had a common origin in the New World.

In regard to the shrikes, which started this survey, it is interesting that the least typical genera, whose relationships are most debatable, show the most distinct plantar scutellation (*Eurocephalus, Nilaus*), and the greatest variability (*Lanioturdus*, [monotypic, i.e. individual variation] and *Prionops* [individual and from species to species]). However, there is complete intergradation in this character with some more typical *Tchagra* and *Lanius*. Thus the presence or absence of tarsal scutellation in this group cannot be used, as was done in the past, to mark either family or subfamily limits.

Since the above was written an exceptional situation was found in some vireos of the genus *Hylophilus*. The tarsus of *H. ochraceiceps* is not acutiplantar but is latiplantar, with the back of the tarsus smoothly rounded, non-scutellate, and without a break at the midline. This is very different from the normal acutiplantar condition in *H. decurtatus* and in the rest of the oscines (except the larks), and recalls the condition in some tyrant flycatchers (Tyrannidae) and in the larks.

At first it seemed that the unusual condition in *H. ochraceiceps* might necessitate removal of the species from the oscines and allying it with the Tyrannidae, characterized by an exaspidean tarsus. However, *ochraceiceps* has a typical oscine aftershaft, and has the general structure, and appearance of a vireo. Though its habits seem little known, it seems that *ochraceiceps* is a vireo, as Ridgway (1904, *U. S. Nat. Mus. Bull.*, 50:214–218) considered it.

The difference between the details of the tarsus in *ochraceiceps* and in *decurtatus* raised the question as to whether a generic separation was advisable to call attention to this difference.

In *decurtatus* the acrotarsium is lightly scutellate and the two plantar plates meet behind at a sharp angle. In *ochraceiceps* the acrotarsium has the scutellation lightly indicated and the outer plantar plate is closely fused with the acrotarsium, and curves around the back of the tarsus, past the midline, to be separated from the inner edge of the acrotarsium by a groove, which is broad proximally, narrow or lacking distally (lined with the remnant of the inner plantar plate?).

However, the difference between these two conditions is bridged by that in certain other

species I have examined: *H. flavipes, H. thoracicus, H. poicilotis,* and *H. pectoralis.* It would seem that this latiplantar, quasi-exaspidean condition is best interpreted as a modification of the oscine acutiplantar condition. An attempt to divide *Hylophilus* into two genera would necessitate setting arbitrary limits and would be impractical.

In this case, an attempt to use tarsal scutellation as a "key character" for classification fails and recalls that Ridgway also had trouble (1907. *U. S. Nat. Mus. Bull.*, 50:336) when attempting to use the variations in the tarsal envelope for arranging the members of the Tyrannidae. He wrote, ". . . they have disappointed me . . . they seem of little value beyond the definition of genera (even sometimes failing here!) or minor supergeneric groups; indeed, it has been found that each of them is more or less variable within what appears to be proper generic limits."—A. L. Rand, *Chicago Natural History Museum, Chicago 5, Illinois, December 29, 1958.*

"Foot-paddling" feeding behavior in a Semi-palmated Sandpiper.—On August 5, 1958, I made the following observation on a mud flat in Newburyport Harbor, eastern Massachusetts. Together with several other species of shore birds, a number of Semipalmated Sandpipers (*Ereunetes pusillus*) were feeding approximately 20 yards from my position on the edge of the flat. As the incoming tide slowly covered the mud, a number of small, shallow pools began to form, and the sandpipers were observed to probe in these pools as well as in the surrounding mud. I focussed my binoculars on one individual which had stopped momentarily to preen. Shortly afterward, this bird waded into a small pool about two feet in diameter, and began to "foot-paddle." With its body held horizontally, bill pointed down, the bird began alternately to lift and depress its legs very rapidly. The entire body of the bird moved rhythmically with the alternating motions of the feet and tarsi. The bird would paddle for about ten seconds, peer at the surface of the water for a moment, then stab rapidly. The movements of the bill were stabs, not probes in the mud. Three such stabs appeared to be successful in securing prey, since the bird made brief swallowing movements after each stab. The food secured by the use of "foot-paddling" was not identified. The entire behavior lasted three minutes, and it appeared to be terminated by the incoming tide flooding the temporary pool.

A cursory review of the literature revealed no mention of this behavior for the Semipalmated Sandpiper, although similar feeding techniques have been observed in other species of sandpipers.—Andrew J. Meyerriecks, *Hatheway School of Conservation Education, Drumlin Farm, South Lincoln, Massachusetts, September 25, 1958.*

Tarsal oiling by a banded Fox Sparrow.—On April 2, 1958, I observed a Fox Sparrow (*Passerella iliaca*) anoint its tarsi after manipulating its uropygial gland. Similar behavior of a Lark Sparrow (*Chondestes grammacus*) has been described by Whitaker (1957. *Wilson Bull.*, 69:179–180), apparently the only other published report of this behavior. My observations were made at the Drumlin Farm Sanctuary near Lincoln, Massachusetts, where I was studying the morphology and sequence of maintenance activities of emberizines upon release from banding. This Fox Sparrow was banded with one aluminum band, inspected for fat and molt, measured, weighed, and released at about 12:45 p.m. Maintenance activities, such as preening and shaking, are given quite readily after banding, and it is assumed that handling and ruffling the feathers during the process accentuate exteroceptive stimuli which release these motions.

Oiling was performed three times, once on each leg after manipulation of the uropygial gland, and once on the unbanded leg after preening the breast. The actual oiling movements were not elaborate. Having just manipulated the preen gland, the Fox

Sparrow rubbed the side of its bill down the tarsus from the tarsal joint to the toes, where the motion ended. This was repeated on the other leg except that the motion ended at the band. Whether or not the band was partially responsible for stimulating the oiling motions cannot be ascertained, but several other Fox Sparrows banded the same day did not anoint the tarsi while preening. During the motion, the bird did not raise its leg from the limb, but instead bent its head down to oil the tarsi. The second occurrence, where only one leg was oiled, took place after the bird had preened down the breast, and the two motions nearly blended. This motion also stopped at the toes.

Mrs. Whitaker (*op. cit.*) described carefully the manner in which her captive Lark Sparrow performed these motions, and also reported that Mrs. A. Nelson has seen tarsal oiling by a captive House Sparrow (*Passer domesticus*). The behavior of my banded Fox Sparrow was similar to that of the Lark Sparrow in several respects: both birds rubbed the tarsi only while preening, both species performed bill wiping and shaking movements before but not during the oiling, and the sequence of motions after tarsal oiling ("usually starting by pulling at mid-breast feathers and then stropping remiges of either wing," Whitaker, *op. cit.*) was similar for both. There are, however, some differences. The Lark Sparrow thrust one foot forward in order to rub it, whereas my Fox Sparrow oiled the leg while still grasping the perch with both feet. Also, the Fox Sparrow did not oil its toes as the Lark Sparrow sometimes did. Certain relationships in sequence of movements in the Lark Sparrow did not hold true in the Fox Sparrow. For instance, the Lark Sparrow always bathed before oiling, which was not true of the Fox Sparrow, although a slight rain that was falling may have provided similar stimulus to the latter bird. Furthermore, tarsus oiling always came before breast preening in the Lark Sparrow, whereas the order of the two was variable in my Fox Sparrow. Finally, once preening of feathers began, the Lark Sparrow neither used the oil gland again nor rubbed the tarsus again, whereas the Fox Sparrow did both.

The significance of species differences in morphology and sequence of oiling and other maintenance activities cannot be evaluated from such short observations as these. Problems concerning the biological function of tarsal oiling and its possible connection with molt of tarsal scales are discussed by Whitaker (*op. cit.*) and nothing new can be added here. It is suggested that bird-banders who inspect their birds in the hand and watch them after release can contribute valuable information about this rare behavior trait.

I am indebted to Carl W. Helms for his help in the banding experiments, and to Dr. William H. Drury, Jr., Director of the Hatheway School of Conservation Education at Drumlin Farm for the use of a wire recorder and banding equipment which were used in the experiments.—Jack P. Hailman, *4401 Gladwyne Drive, Bethesda 14, Maryland, January 16, 1959.*

The taxonomy of the Robin in Mexico.—The taxonomic treatment accorded *Turdus migratorius* in the Mexican Check-List (Miller, *et al.*, 1957. *Pac. Coast Avifauna*, 33:1–436) was something of an innovation. However, no supporting data were presented. My own study generally confirms this arrangement and provides data. I studied 193 adult-plumaged Robins from Mexico, plus over 100 specimens of *T. m. propinquus* from western United States, and a few of each of the other races.

I acknowledge, with thanks, the courtesy of Dr. Robert T. Orr, at the California Academy of Sciences, and of Dr. Robert H. Storer at the University of Michigan Museum of Zoology. The curators of the University of California Museum of Vertebrate Zoology, the Chicago Natural History Museum, the University of Kansas Museum of Zool-

ogy, and the United States National Museum courteously loaned me their Mexican Robins.

The chief size difference which has been claimed as differing geographically is wing length. The data in Table 1 suggest that even this is a poor character. There is a weakly-marked cline of wing length, decreasing from the southern Rocky Mountains southward through northwestern Mexico to the Transvolcanic Range in Jalisco, thence eastward, and culminating southward in Guerrero in the smallest population.

TABLE 1
WING LENGTH (IN MM.) OF ADULT MALE ROBINS

Race	Locality	Size of Sample	Range	Mean	Standard Deviation	Coefficient of Variability
propinquus	California and Nevada	25	130–139	135.0	2.74	2.03
"	Southern Arizona and Northern Sonora	11	132–139	136.9	1.75	1.28
"	Northeastern New Mexico and western Texas	12	134–144	138.1	3.27	2.37
"	Northwestern Chihuahua	10	137–145	140.2	2.12	1.51
"	Southwestern Chihuahua, Durango, and western Zacatecas	11	132–144	135.5	3.77	2.78
phillipsi	Jalisco and Michoacán	16	129–141	134.9	3.36	2.49
"	Nuevo Leon, Morelos, Oaxaca, and state of Mexico	5	129–139	134.4	—	—
"	Guerrero	41	130–138	133.9	2.45	1.86

Color shows a definite cline of increasing dorsal darkness and ventral brightness, from southwestern United States southeastward to southern Mexico. The most definite step in the material studied occurred at the Zacatecas–Jalisco border.

Sexual dimorphism in color is rather prominent in the Robin, but males from one population are sometimes similar to females from another population. Fall specimens in fresh plumage were the basis for the statements on color made herein; however, carefully sexed adults in worn plumage could be identified.

The two races breeding in Mexico are:

Turdus migratorius propinquus Ridgway

Turdus propinquus R. Ridgway, *Bull. Nuttall Orn. Club*, 2:9, 1877 (Laramie Peak, Wyoming).

Lacking the white tail corners of *migratorius*, *achrusterus*, and *nigrideus*; paler throughout and less reddish ventrally than *caurinus*; as compared with *phillipsi*, paler dorsally, less bright-ochraceous and either redder or duller ventrally, averaging less blackish on the throat, and with more white flecks ventrally.

There is considerable variation within the range of *propinquus*. The populations of the southern Rocky Mountains and northwestern Mexico are grayer, less brownish dorsally than those of California, Oregon, and Nevada; as well as paler, less reddish, ventrally. Certain specimens from the southern Sierra Madre Occidental, in Zacatecas and southern Durango, approach *phillipsi* in brightness of the ventral ochraceous.

Range: (based on specimens examined) Breeding in western United States, and mountains of northwestern Mexico south to southern Durango and western Zacatecas. South in winter as far as Guerrero and state of Mexico.

Turdus migratorius phillipsi Bangs

Turdus migratorius phillipsi O. Bangs, *Proc. Biol. Soc. Wash.*, 37:125, 1915 (Las Vigas, Vera Cruz).

Similar to *propinquus*, but darker and often browner dorsally; a brighter hue of ochraceous and often less reddish ventrally; averaging blacker on the throat; and with fewer white flecks ventrally. As compared with *caurinus*, more ochraceous, less ruddy ventrally.

The population of Jalisco and Michoacán approaches *propinquus* in that it averages paler dorsally and duller ventrally than that of eastern Mexico and Guerrero. A few of the specimens from eastern Mexico (Hidalgo, Vera Cruz, etc.) are perhaps slightly ruddier, less ochraceous ventrally than any comparable ones from southwestern Mexico (Guerrero), but the tendency is difficult to discern and in my opinion does not even approach the order of a subspecific distinction. In other words, I regard *T. m. permixtus* Griscom as a synonym of *phillipsi*.

Range: (based on specimens examined) Resident from Jalisco, Michoacán, and Nuevo Leon south to Guerrero and Oaxaca.

Mexican Specimens Examined.—Sixteen specimens are unidentifiable to race because of lack of sexing, or questionable sexing, in conjunction with worn plumage. Spotted juveniles are not included. Migrant and wintering specimens are included.

T. m. migratorius—Yucatán 1, Vera Cruz 1, Nuevo Leon 2.

T. m. propinquus—Guerrero 6, Michoacán 1, state of Mexico 1, Guanajuato 1, Zacatecas 14, Durango 6, Chihuahua 13, Sonora 4.

T. m. phillipsi—Jalisco 17, Michoacán 11, Nuevo Leon 1, state of Mexico 3, Hidalgo 1, Federal District 1, Puebla 1, Vera Cruz 2, Oaxaca 1, Guerrero 76.

J. Dan Webster, *Hanover College, Hanover, Indiana,* and *California Academy of Sciences, San Francisco, February 27, 1959.*

Octaves and kilocycles in bird songs.—In recent years physicists have discovered a means of recording sounds in visible marks. This is by machines such as the audiospectrograph (Kellogg and Stein, 1953) and the vibralyzer (Borror and Reese, 1953). The markings produced in this way are similar to those that I have made representing sounds heard by ear, in that time is represented horizontally and pitch vertically. There are other differences, however, that need explanation so that we may understand both kinds of records.

In the mechanical records pitch is measured in kilocycles. When I first studied the physics of sound the term used was vibration. Brand (1935) used the term frequency. Although technically different terms, cycle, vibration, and frequency have been used by different authors to represent the same attribute of bird song.

In the methods I have used in recording bird songs the pitch is measured in octaves. The octave differs from the kilocycle in that each octave contains twice as many cycles as the previous one (or half as many as the following one). To put it mathematically, in the kilocycle the cycles increase in an arithmetical progression, but in the octave in a geometrical progression. Therefore, the first kilocycle, from 0 to 1000 cycles, begins below the limit of man's hearing and contains all of the octaves up to just below C_5, as Brand (1935) designates it. This is C″ in the method I (1951) used in the Guide to Bird Songs. C″ contains 1024 cycles. The next kilocycle is almost coincident with the next octave, which extends from 1024 to 2048 cycles. After that, the two octaves from C‴ to C⁗, the place where the songs of most of small bird singers are pitched, contains no less than six kilocycles.

A division of the octave is a tone. We cannot say just how many cycles a tone contains because that depends on just where it is in the musical scale. For example, the difference in pitch of the two notes in the "phoebe" whistle of the Black-capped Chickadee (*Parus atricapillus*) is not always on the same pitch, for an individual bird may sing it from B to A, and then change and sing it from A to G. I do not mean to imply that the pitch of the bird note is exactly what musicians refer to as concert pitch, but I do mean that if the bird's A is a few cycles off concert pitch, its G is also off enough to make the interval a perfect tone.

A great many of our bird songs contain intervals based on tones and their multiples: thirds, fourths, fifths, and octaves. The most common form of the song of the White-throated Sparrow (*Zonotrichia albicollis*), for example, has a perfect fourth between the first and second notes (Saunders, 1951:269, Fig. 159, No. 1). It is as if the bird sang its *Old Sam* on the notes "sol do." In the song of the Ruby-crowned Kinglet (*Regulus calendula*) the interval between the first and second parts is frequently, but not always, an exact octave (Saunders, 1951:153, Fig. 80). Natural music of both man and birds has been that way since long before man invented our present system of writing music. Chords and harmonies are recognized without realization of what it is that makes them such. Some people may not appreciate this due to a lack of musical "ear." Others, who are naturally musical, but not trained to know just what it means, may appreciate such things. When a group of men and women sing together some familiar air, the men actually sing one octave lower than the women without realizing it. They could not possibly sing one kilocycle lower. Those who have no musical "ear" should not attempt to describe bird songs, nor to criticize those who do so, any more than a color-blind person should attempt to describe birds' plumages.

The mechanical method of recording, because it relies on kilocycles, rather than octaves, seems to hide the music in bird songs. On the other hand it does show things that recording by ear cannot. In the study of the Wood Thrush (*Hylocichla mustelina*) songs (Borror and Reese, 1956), it shows that the bird can sing three notes at the same time. This is a matter that I once noted in a Cardinal (*Richmondena cardinalis*) when a bird sang two distinct songs at once, and I could hardly believe my ears (Saunders, 1923), so I am glad to have my experience corroborated.

In the matter of time, especially in very short notes or songs, the mechanical recordings are much more accurate than the stop-watch. The shortest time registered by a stop-watch is ⅕ of a second. Very short songs such as that of Henslow's Sparrow (*Passerherbulus henslowii*), or a single *chebec* of the Least Flycatcher (*Empidonax minimus*) cannot be timed shorter than this with a stop-watch, but the mechanical recordings show that the songs can be much shorter (Borror and Reese, 1954), and that in the Henslow's Sparrow a song that sounds like two notes may be as many as five.

Bird songs are characters of living birds that have just as much to do with distinctions between species as do the characters that are retained in bird skins. The audio-spectrograph has shown that two different kinds of Traill's Flycatcher (*Empidonax traillii*) occur in central New York, and photography shows that they build distinctly different nests (Kellogg and Stein, 1953). This would seem to be good evidence that they are different forms, but the taxonomists have not indicated at what taxonomic level.

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Aretas A. Saunders, *P. O. Box 141, Canaan, Connecticut, May 8, 1959.*

Early and elaborate nests of the Killdeer in Hancock County, Ohio.—The beginning of the nesting season for the Killdeer (*Charadrius vociferus*) in Ohio is usually given as "April," although it sometimes begins in March. On March 31, 1946, I found a Killdeer nest containing four eggs in front of the clubhouse of the Skeet Club, two miles southeast of Findlay, Ohio. On March 24, 1945, I found a nest containing three eggs in a stone quarry in Findlay. A fourth egg was laid on March 26.

The Killdeer may build a nest more often than is popularly supposed. Of 10 nests found in recent years, two have been elaborately constructed. One of these was found between two rows of plants in a soybean field on June 30, 1948. It contained four eggs. This nest was built in a slight depression, the bottom of which was paved with small pebbles. These stones were flat and about half an inch wide.

The other elaborately constructed nest was the March 24 nest mentioned above. This nest was four inches in diameter, placed in a slight depression, and surrounded by a rough circle of eight pieces of limestone, averaging two inches in height. The area between these rocks had been paved with approximately 180 flat pieces of limestone and coal. The paving material toward the center of the nest averaged one-fourth inch in diameter. The outer edge of the nest was higher than the center and consisted of larger pieces of stone and coal averaging one-half inch in diameter. The four eggs in this nest hatched before 9:00 a.m. on April 19.—Richard Stuart Phillips, *834 Liberty Street, Findlay, Ohio, February 11, 1959.*

A hybrid White-crowned × White-throated Sparrow.—On several occasions at Fort Belvoir, Fairfax County, Virginia, in December, 1957, and January, 1958, several people, including P. A. DuMont, Donald Lamm, and I, had excellent views of what were thought to be at least three adult Gambel's Sparrows (*Zonotrichia leucophrys gambelii*). The birds were in a mixed flock of sparrows, including nine or 10 White-crowned Sparrows (*Z. l. leucophrys*). I collected one of the three supposedly Gambel's Sparrows on January 5, 1958, at Fort Belvoir. The specimen was prepared as no. 468554 (U. S. National Museum).

The specimen was not prepared until mid-May but was then compared carefully to specimens of the genus *Zonotrichia* in the USNM. In the opinions of Dr. Alexander Wetmore, Dr. John Aldrich, Dr. H. Friedmann, and Mr. H. G. Diegnan, specimen no. 468554 is a hybrid between White-crowned and White-throated (*Z. albicollis*) Sparrows, and not an example of Gambel's Sparrow.

The two most convincing characteristics which led to this conclusion are: (1) The very broad and large white loral area corresponding exactly in size and shape with that area in *Z. albicollis* (which is yellow in adults of that species). This same area in every specimen of *Z. l. gambelii* at the USNM is much narrower and more confined. (2) The coloration

of the feathers at the bend of the wing in specimen no. 468554, and in all those of *Z. albicollis* in the USNM are lemon yellow, whereas this same area is cream or white in specimens of *Z. l. leucophrys* and *Z. l. gambelii*.

Several other pertinent features of the hybrid specimen are: (1) Extreme amount of chestnut in the edgings of the secondary wing feather corresponding well with the majority of specimens of *Z. albicollis*, whereas in specimens of *Z. l. leucophrys* and *Z. l. gambelii*, this color, if present, is either confined to a much narrower area on each feather and to a less extensive area on the wing, or is darker (almost umber) in color. (2) The nearly pure white belly and pure gray breast of the specimen which match the normal shades of *Z. albicollis* rather than the darker gray and/or brownish-tinted coloring of these areas in nearly all specimens of *Z. l. leucophrys* and *Z. l. gambelii*.

This appears to be the first known specimen of a hybrid between *Z. l. leucophrys* and *Z. albicollis*. Cockrum (1952. *Wilson Bull.*, 64:150) reported no record of such a hybrid. A search of the literature since that date has revealed no notation of previous examples of such a hybrid as this one.—Jackson M. Abbott, *1100 Doter Drive, Alexandria, Virginia, January 12, 1959.*

A nesting colony of Forster's Terns and Black Skimmers in Southwestern Louisiana.—From July 12 to August 18, 1958, a small breeding colony of Forster's Terns (*Sterna forsteri*) and Black Skimmers (*Rynchops nigra*) was observed on Rockefeller Refuge in southwestern Louisiana. The refuge is an expanse of marshland adjacent to the Gulf of Mexico. The nesting birds were concentrated on two low clay levees on the margin of Deep Lake, approximately four miles inland from the coast. The levees were parallel and separated by a canal 150 yards wide. Each levee was about five yards wide by 400 yards long, and the maximum height of either area was 18 inches above water level. Waves frequently washed across the levees in several locations. Nesting was concentrated at the ends of the levees. The vegetation was very sparse and consisted of scattered clumps of *Spartina alterniflora*, *Distichlis spicata*, and *Heliotropium curassavicum*.

The average population of the colony was 165 Black Skimmers (range 118 to 207) and 53 Forster's Terns (range 46 to 57). Actual nest concentration of the two species, however, was about equal. Maximum nest counts, on nine checking dates, were 76 Black Skimmer nests and 62 Forster's Tern nests. There were nearly three times as many skimmers as there were skimmer nests, but there was approximately one tern for each tern nest. This suggests that the Black Skimmer population was composed of breeding and non-breeding birds of both sexes. The Forster's Tern population, however, probably consisted of nesting birds of only one sex.

Terns and skimmers nested close together on both levees, but the ratio of the nesting species in the two locations was quite different. On the north levee the ratio of Forster's Tern nests to Black Skimmer nests was 4:1. The ratio was just the reverse on the south levee. There was no apparent conflict between species.

The Black Skimmer nests were merely depressions in the hard clay. The tern nests were prominent conical mounds of dead marsh vegetation, each containing a definite depression on top. The number of eggs per nest was about three for both species. Many skimmer eggs, particularly on the south levee, were concentrated at the water edge. They had either been laid at random, thrown from the nest, or washed from the levee by high waves.

The height of nesting occurred in the tern population on July 12, but the Black Skimmer population did not attain a nesting peak until July 25. Downy young terns

were first observed on July 14, and Black Skimmer young were not seen until July 30. Nesting was completed for the terns by the first week of August, but the majority of the skimmer eggs had not hatched until August 18.

Egg-laying dates of this particular colony are unusually late. Probably this represents at least a second nesting effort of both species. Low, exposed levees projecting into open expanses of water would be precarious sites, quite vulnerable to inundation.—J. L. CHAMBERLAIN, *Department of Biology, Randolph–Macon Woman's College, Lynchburg, Virginia, February 22, 1959.*

NEW LIFE MEMBER

Donald N. Bucknell, of Ingersoll, Ontario, is joining the growing number of Life Members of the Wilson Ornithological Society. His interest in ornithological natural history is an avocation from his exacting duties as a time-study- and standards-analyst for a manufacturing firm. Mr. Bucknell is a past-president of the Ingersoll Nature Club, and is also a member of the A. O. U. and the Federation of Ontario Naturalists. He also spends considerable time and energy as Scout Leader of a troop of 36 boys, instructing them in his special interests in birds and plants.

ORNITHOLOGICAL NEWS

We are happy to announce that Betty Carnes has become the third Patron of The Wilson Ornithological Society.

Louis Agassiz Fuertes Research Grant

Although it was not possible to make a grant this past year, the Research Grant Committee hopes to make an award for 1960. Application forms may be obtained from the Chairman, Harvey I. Fisher, Southern Illinois University, Carbondale, Illinois. Completed applications must be received by March 1, 1960.

The Committee wishes to emphasize that any type of ornithological research may be supported and that recipients need not be affiliated with educational institutions. In fact, the Committee hopes to encourage the development of research by amateur ornithologists. The important criterion in awarding funds will be the contribution to knowledge intrinsic to the work envisioned. It will be easier for the reviewers to judge the potential of a problem if work is already in progress. Consequently, applicants should prepare careful outlines of their projects and include information already obtained.

The Committee trusts that those interested in ornithology will encourage donations to the research fund and will stimulate qualified persons to apply for grants. It is felt that the amateur ornithologists of the United States constitute a virtually untapped source of research effort. We can increase ornithological knowledge a great deal by proper inspiration of and help for these workers.

Request for Information

As part of a study of the shorebird population on the Florida Gulf coast, a large number of Short-billed Dowitchers, Semipalmated Plovers, Dunlins, and lesser numbers of other waders were trapped, banded and color-dyed in the spring, 1959. Birds caught in May were dyed a vivid golden color which is known to have remained unaltered after at least one month on a dowitcher. Birds trapped in June were dyed scarlet, though dyed birds seen two weeks later were only pinkish in hue. All birds dyed were presumed to be in northward migration. Other colors will be used in the fall, 1959.

It is earnestly requested that anyone observing such colored shorebirds please communicate promptly with me, stating color, species, and date and location of observation. —*Horace Loftin, Department of Biological Sciences, Florida State University, Tallahassee, Florida.*

ORNITHOLOGICAL LITERATURE

THE BIRDS OF THE PALEARCTIC FAUNA. Passeriformes. By Charles Vaurie. H. F. & G. Witherby, London, 1959: 10¼ × 7¼ in., xii + 762 pp. $16.00.

There are two principal ways of going about the preparation of a check-list for any major geographic area. It may be done by a committee, usually composed of members appointed by the pertinent scientific organization, sometimes of individuals with a common interest in the region in question. Among bird lists, these two variations of the first approach are exemplified by the A.O.U. and B.O.U. Check-lists, and the "Check-list of the Birds of Mexico," respectively. The second method is that of single authorship, in which one man takes on the job, soliciting help and advice from his colleagues as required, but unhampered by any committee structure. Examples of this approach include the well-known works on Africa by Sclater, Australasia by Mathews, the West Indies by Bond, Colombia by de Schauensee, the first seven volumes of the Peters "Check-list of Birds of the World," and numerous others.

The publication of the first volume of Dr. Vaurie's important work on Palearctic birds helps to confirm the opinion, held by many, that the single-author approach is the preferable method of producing a major check-list. Speed of publication is one important factor; the first paper in Vaurie's preliminary series of "Systematic Notes" appeared in December, 1953, and he was reading page-proofs of the present volume less than five years later. This contrasts with the 18 years that elapsed between the formation of a committee to prepare a fifth edition of the A.O.U. Check-list and the actual publication of that volume. It is acknowledged that the comparison is not wholly a fair one; the 18-year span included the period of World War II, and throughout the entire time most of the committee members could devote only a relatively small proportion of their working hours to the Check-list. It is true, too, that Vaurie's volume includes only the Passeriformes, but the scope of the information included in his check-list substantially exceeds that in the A.O.U. list. These statements must not be construed as criticisms of the individual members of the A.O.U. Check-list Committee, nor as a suggestion that a single author prepare the sixth edition of the A.O.U. list. The comparison is made primarily to indicate the magnitude of the task Vaurie has accomplished (he is well underway in the writing of the second volume).

The somewhat pedantic title of Vaurie's work was undoubtedly chosen to acknowledge its relationship to Hartert's classical "Die Vögel der Paläarktischen Fauna" (1903–1922). Vaurie has chosen, quite rightly, not to duplicate much of the substance of Hartert's work (keys, detailed descriptions, complete synonymies) in the new book. On the other hand, information presented for each species far exceeds that in most check-lists. Post-Hartert synonymies, together with references to major revisions and monographs, are given, but detailed systematic discussions (frequent in Hartert) were published separately in Vaurie's preliminary series of 33 "Systematic Notes on Palearctic Birds"; the working systematist should have this series bound as a companion volume to the check-list itself.

The geographic range is given for both the species as a whole and for each subspecies, as in the A.O.U. Check-list; there is also a list of extra-limital subspecies. A useful addition to the statement of species range is a brief description of preferred habitat. English vernacular names are supplied for all species, and French and German names for species occurring in countries using those languages. Since all of these are separately indexed, there are thus *four* indices: for English, French, German, and scientific names.

One of the chief characteristics of the single-author check-list, as opposed to the committee or A.O.U. type, is its uniformity of viewpoint. The responsibility for all taxonomic

decisions is the author's, unless otherwise stated. This fact can be helpful to later workers who may wish to discuss or dispute a point with the author; in the case of the A.O.U. Check-list, it is virtually impossible to determine how and by whom any given taxonomic decision was made. The uniformity of viewpoint of the single-author check-list *can* be something of a shortcoming if the author happens to be an extremist of either the "lumping" or the "splitting" schools. In lists published by lumpers, the reader usually has no way of knowing whether subspecific names have been synonymized by the author on objective (i.e., nomenclatorial) or subjective (i.e., taxonomic) grounds. Vaurie, who tends to be somewhat of a lumper at the subspecies level, has overcome this difficulty in an ingenious way. First, for many polytypic species he has included a general paragraph on geographical variation, pointing out the nature of the important trends of variation within the species as a whole. Each subspecies which is considered to be well differentiated takes its place in the list without further comment. Moderately-well differentiated subspecies also have regular positions on the list, but are prefixed by the symbol (o). In the synonymies, those names regarded as absolute synonyms appear without comment, while those names which have been given to populations considered by Vaurie to be insufficiently differentiated to be worthy of nomenclatorial recognition are prefixed with an asterisk, and a comment on their status (usually stages on a cline) often appended. This system will undoubtedly represent a genuinely helpful tool to workers who may wish to re-evaluate Vaurie's treatment of a given species.

I do not propose to comment on Vaurie's taxonomic treatment of any particular group of birds. No specialist will read this (or any other) check-list without finding some occasion to differ with the author. My own studies, for instance, have led me to conclusions differing from Vaurie's in (among others) *Hirundo daurica* and *Passer montanus*. Such differences of opinion are inevitable among taxonomists, and certainly do not affect the usefulness and importance of Vaurie's book.

One of the major contributions of the present check-list lies in its detailed and up-to-date treatment of the distribution of the birds of the eastern portion of the Palearctic region, an area whose very geography (much less its avifauna) is unknown to most westerners. Vaurie has had the benefit of extensive correspondence with Russian ornithologists, and has been able to avail himself of literature and specimens seen by few, if any, other western workers. An excellent gazetteer and two sketch maps (Turkestan and western China) are invaluable aids to the understanding of Asian distribution patterns. Even more maps would have been a great convenience, but the latitudes and longitudes given in the gazetteer will enable the reader to locate most places on National Geographic or other readily available maps.

In view of the substantial number of species appearing on both lists, differences between the treatment of the A.O.U. Check-list and that of Vaurie's book will be of interest to American readers. These differences are relatively few, and concern mostly species accidental in North America (the non-passerine volume will naturally include a much larger number of holarctic species). Among the birds other than these accidentals, the following departures from A.O.U. usage were noted:

Petrochelidon is reduced to a subgenus of *Hirundo*; *Anthus spinoletta pacificus* Todd is mentioned in a footnote, but *A. s. alticola* is omitted; *Lanius excubitor invictus* may not be separable from *L. e. sibiricus*; *Corvus corax clarionensis* is omitted from the list of extralimital races of the species; the Bohemian Waxwing is *Bombycilla garrulus*, not *B. garrula*; the subfamily Regulinae is not recognized as separate from the Sylviinae; the latter group and the Turdinae are considered subfamilies of the Muscicapidae; *Catharus* is used for the three species of "*Hylocichla*" known from the Palearctic; the Aegithalidae and Remizidae are given full family rank (the former would include the Bush-tits and the

latter the Verdin); the Sittinae are treated as a subfamily of the Paridae; *Spinus* (but not *Acanthis*!) is considered a synonym of *Carduelis*; *Acanthis flammea holboelli* is not recognized (considered a doubtful race in the A.O.U. Check-list); the North American rosy finches are considered races of the Old World *Leucosticte arctoa*; and the Emberizidae are given full family rank.

The volume itself is an outstandingly attractive piece of book-making. The typography is particularly handsome, and a light-weight but strong and opaque paper permits this book of almost 800 pages to be handled easily. The binding is perhaps a little flimsy for the amount of use to which many people will put the book, but that has been a shortcoming of many products of English publishers in recent years. The text is remarkably free from typographical errors. There is one *lapsus calami*: on pp. 541 and 542, the species name *familiaris* was inadvertently substituted for *brachydactyla* in the discussion of geographic variation in the Short-toed Tree Creeper.

Dr. Vaurie has made a major contribution to the basic literature of ornithology, and many of us will await with impatience the publication of the second volume.—Kenneth C. Parkes.

The Waterfowl of the World. By Jean Delacour. Volume Two. The Dabbling Ducks. Country Life Limited, London, 1956: 8 × 10 in., 232 pp., 29 maps and 24 color plates by Peter Scott.

This second volume of Jean Delacour's series continues the attractive and somewhat sumptuous format established by the first, with wide margins, good paper, numerous maps and a generous 24 full-color plates. It covers the dabbling ducks or tribe Anatini and follows, in general, the classification proposed by Delacour and Ernst Mayr in *The Wilson Bulletin* for 1945.

The genus *Anas* is broadly interpreted, including 38 species and 74 retained subspecies, or essentially all the familiar dabbling ducks and their related species in other hemispheres, plus Salvadori's Duck (*A. waigiuensis*) of New Guinea and the Ringed Teal (*A. leucophrys*) of South America.

In addition, five monospecific genera of doubtful position, or those showing relationship to both dabbling and diving ducks, are included. These are: *Rhodonessa*, the Pink-headed Duck of India; *Malacorhynchus*, the Australian Pink-eared Duck; *Hymenolaimus*, the Mountain Blue Duck of New Zealand; *Stictonetta*, the Freckled Duck of Australia; and *Merganetta*, the Torrent Ducks of South America. This last genus is included on the basis of Niethammer's anatomical studies (1952. *Jour. f. Ornith.*, 93:357–360).

It is indeed fortunate that the author is a "lumper" who sees relationships as more interesting than differences. He may thus save a generation of us interested in waterfowl from the confusion of the "splitters."

It is wonderful to find within the same covers all the most pertinent information on this popular group of birds—not only color plates and distribution maps of every species and subspecies, but significant taxonomic features, basic synonymy, incubation periods, behavior observations, and a very thorough summary of the history of each in captivity. In addition to the essences of the widely scattered literature which Delacour has distilled for us, there is a great deal of new observation drawn from the author's wide experience and from unpublished studies still being pursued by others, such as those of Harry Frith on the Pink-eared and the Freckled Ducks in Australia.

The color plates again show the great artistic skill of Peter Scott. It is his eye for design that permits 12 to 14 ducks to be shown on one plate. Although all are oriented alike to

facilitate comparisons, an interesting posture or displacement preen is deftly used to make more room and to prevent any feeling of crowding. Excellent color reproduction has preserved every detail, down to the highlight in the delicate translucent pink eye of the Cape Teal (Plate XV, p. 142). Differences in leg color due to age, sex or season seem to have been ignored in some species, such as the Shovelers, and, although mentioned in the text for the American Black Duck, have been lost on the plate. (For color documentation of these differences see Shortt, 1943, *Wilson Bull.*, 55:3–7.)

Subspecific differences are elaborately illustrated in all cases, even when poorly defined or based on size alone (Aleutian and Eastern Green-winged Teals, Plate IX, p. 98; Crozet and Kerguelen Pintails, Plate XIV, p. 134; and the Cinnamon Teals, Plate XIX, p. 182).

Never before have color plates of ducklings of all the species of waterfowl been presented in one work—truly a major contribution in itself.

The distribution maps show no overlap in winter and summer ranges for any species. This adds to the clarity at the expense of some accuracy. Neither maps, keys nor plates are cross-referenced; this eliminates possibility of the usual errors. All can be readily found by reference to the index where scientific and common names are listed separately.

By a man's biases you shall know him, and so from his book you will know those of Jean Delacour. That he is a sportsman is revealed when he says of the Blue-winged Teal, "They are good sporting birds but their flesh is not of very good quality" (p. 163). When he says a species "is rather coarse in shape" he reveals the poultryman's eye. As an ardent aviculturist he sees the opportunities to use aviculture as a means for preserving endangered species (such as the Laysan Teal). Speaking of the Auckland and Campbell islands he says, "Since their islands have been invaded by man and the animals that follow him, Brown Teal have considerably decreased in numbers and are now facing extinction. The resources of aviculture should be employed for their perpetuation" (p. 81). The fact that the New Zealand Grey Duck is rapidly being lost through progressive hybridization with introduced Mallards gets but passing mention.

Apparently the English editors could not resist correcting American spelling (program to programme, p. 48) even in a direct quotation!

As I read through this fascinating and beautiful volume I was intrigued by the generalizations that seemed to be emerging: The tendency for island populations to become white-spotted or darker and smaller in stature; the frequency of loss of one or the other plumage (eclipse or nuptial) in the southern hemisphere; the breakdown of sexual dimorphism in this region, and the increasing frequency of the male staying with his mate and aiding in rearing of the young; and the rarity of seasonal migration from austral areas. Anticipation of an elaboration of these and many other biological features will make us eagerly await the appearance of the final volumes in this series.—WILLIAM H. ELDER.

PROCEEDINGS OF THE FORTIETH ANNUAL MEETING

BY AARON M. BAGG, SECRETARY

The Fortieth Annual Meeting of the Wilson Ornithological Society was held at Rockland, Maine, from Thursday, June 11, to Sunday, June 14, 1959. The meeting was sponsored by the Portland Society of Natural History, the Farnsworth Museum, and the Maine Audubon Society. The Local Committee, under the efficient co-chairmanship of Christopher M. Packard and Wendell Hadlock, performed a truly outstanding piece of work in organizing the meeting and in providing the 302 registered members and guests with all conceivable information on events and field trips.

Four sessions were devoted to papers, and two business meetings were held, all in the Farnsworth Museum. The meeting opened with an informal reception in the museum on Thursday evening, when Carl W. Buchheister, of the National Audubon Society, presented the fine film, *Pastures of the Sea*. Thursday evening was also the occasion for the meeting of the Executive Council, in the museum auditorium. On Friday evening, 239 members enjoyed a real Downeast Clambake, featuring steamed clams, lobsters, and corn. The Annual Dinner was held on Saturday evening at the Thorndike Hotel, with Lawrence H. Walkinshaw presenting the President's Address. This was followed by the first public showing of a most impressive color film, *Sea, Ice, and Fire*, made in Iceland in 1958 by Olin Sewall Pettingill, Jr., whose commentary was as colorful as the superb pictures which he described. The Local Committee had decorated the tables attractively, and souvenir plates featuring puffins were at each place setting. At the head table, each officer received a Wilson's Warbler, carved in wood and kindly presented by Mrs. Dorothy Washington, and a treasure chest of Maine seafood delicacies.

Early-morning field trips to nearby coastal and inland areas were scheduled for Friday and Saturday. On Sunday, through the courtesy of the United States Coast Guard, 168 persons sailed in the buoy-tender *Laurel* to the puffin colony on Matinicus Rock—a sea-cruise which, though attended by day-long rain, was highly successful birdwise; in addition to the Common Puffins, species seen included Northern Phalarope, Sooty Shearwater, Wilson's Petrel, Arctic Tern, Common Eider, and Black Guillemot. Field parties also left on Sunday for Mt. Desert Island, under the leadership of James Bond (species seen included Red Crossbill, Common Raven, Winter Wren, Bay-breasted Warbler), and for Mt. Katahdin, under the leadership of Mr. and Mrs. Wendell Taber.

First Business Session

President Walkinshaw called the meeting to order at 9 a.m., Friday, June 12. Mr. Wendell Hadlock, Director of the Farnsworth Museum, and Mr. Edward F. Dana, President of the Portland Society of Natural History, welcomed the members and guests of the Wilson Ornithological Society. President Walkinshaw responded on behalf of the Society.

The Proceedings of the Thirty-ninth Annual Meeting, as published in *The Wilson Bulletin* for September, 1958, were corrected on the matter of dues. On April 25, 1958, the meeting of members voted to amend the Constitution, as duly proposed previously by mail. Article II, Section 3, Sentence 1 was changed to become: "The amount of the annual dues of Active Members and Sustaining Members shall be determined by the Executive Council in accordance with current requirements." Empowered by this amendment, the Council set the Active Membership dues at $4.00 per year, and the Sustaining Membership dues at $6.00 per year. On motion by Harold Mayfield, seconded by Francis Harper, the members voted the adoption of this correction in the Proceedings of the

Thirty-ninth Annual Meeting. On motion by Mayfield, seconded by Frank Preston, the members approved the Proceedings as corrected.

Secretary's Report

The secretary, Aaron M. Bagg, summarized the principal actions taken at the Thursday evening Executive Council meeting as follows:

1. The Council voted to accept the invitation of the Tennessee Ornithological Society to the Wilson Society to hold its 1960 meeting at Gatlinburg, Tennessee, during May 5–8, 1960.

2. The Council voted to accept the invitation of the Federation of Ontario Naturalists, the Audubon Society of Canada, and the Royal Ontario Museum, to the Wilson Society, to hold its 1961 meeting in the Muskoka District of Ontario in June, 1961.

3. The Council voted to accept an invitation to the Wilson Society to hold its 1962 meeting in Indiana.

4. The Council re-elected H. Lewis Batts, Jr., as editor of *The Wilson Bulletin*.

Treasurer's Report

The treasurer, Ralph M. Edeburn, submitted the following report on the finances of the Society:

REPORT OF TREASURER FOR 1958

GENERAL FUND

Balance as shown by last report, dated December 31, 1957			$ 1,567.07
RECEIPTS			
Dues:			
Active memberships	$6,611.15		
Sustaining memberships	1,942.10	$8,553.25	
Subscriptions to *The Wilson Bulletin*		602.00	
Sale of back issues and reprints of the *Bulletin*		160.09	
Interest on Investments and Savings		533.50	
Library Book Fund		65.50	
Gifts:			
September Color Plate (anonymous donor)	$550.29		
Miscellaneous	118.00	668.29	
Refund—Registration Wheeling Meeting		38.70	
Miscellaneous		7.39	10,682.72
Total Receipts			$12,195.79
DISBURSEMENTS			
The Wilson Bulletin—printing and engraving		$5,378.49	
The Wilson Bulletin—mailing and maintenance of mailing list		830.49	
Editor's Expense—clerical, postage, and telephone		120.00	
Treasurer's Expense			
Stamped envelopes and postage	$166.80		
Printing	140.62		
Safety deposit box (2 years)	6.60		
Typing membership	51.00		
Supplies and miscellaneous	12.74	377.76	
Secretary's Expense			
Stamped envelopes and postage	$ 91.28		

Announcements—annual meeting	93.41		
Programs—annual meeting	55.78	240.47	
Back issue distribution		25.00	
Purchase reprints and books		19.32	
Committee expenses—printing and postage		99.52	
September Color Plate (anonymous donor)		550.29	
Louis Agassiz Fuertes Research Grant		75.00	
Miscellaneous		4.75	
Total Disbursements			$ 7,721.09
Balance on hand in Twentieth Street Bank, Huntington, West Virginia, December 31, 1958			$ 4,474.70

ENDOWMENT FUND

Balance in Savings Account as shown by last report, dated December 31, 1957			$ 1,234.61
RECEIPTS			
Life Membership payments		$1,998.00	
Patron Josselyn Van Tyne (posthumously) (anonymous donor)		400.00	2,398.00
6 shares Mass. Investor's Trust at $13.41 (included below)			
Total Receipts			$ 3,632.61
DISBURSEMENTS			
Louis Agassiz Fuertes Research Grant		$ 25.00	
Purchased—25 Shares Owens-Illinois 4% Cum. Stock		2,487.03	
Total Disbursements			$ 2,512.03
Balance in Savings Account, Twentieth Street Bank, Huntington, West Virginia, December 31, 1958			$ 1,120.58
SECURITIES OWNED			
U. S. Treas. Bonds, 4%, Mature Oct. 1, 1969 (maturity value, $3,000.00)	$3,045.00		
U. S. Savings Bonds, Series "F," dated February 1, 1947 (maturity value, $2,000.00)	1,924.00		
U. S. Savings Bonds, Series "F," dated April 1, 1948 (maturity value, $2,000.00)	1,858.00		
U. S. Savings Bonds, Series "F," dated October 1, 1948 (maturity value, $1,450.00)	1,316.70		
U. S. Savings Bonds, Series "F," dated April 1, 1950 (maturity value, $1,000.00)	874.00		
Total Value of U. S. Bonds		$ 9,017.70	
Kaiser Aluminum and Chemical Co. Stock, 4¾% (15 shares at $110.00)		1,650.00	
Massachusetts Investor's Trust (388 shares at $13.41)		5,203.08	
Fireman's Fund Insurance (70 shares at $59.00)		4,130.00	
Owens-Illinois Glass Co., 4% Cum. Preferred (25 shares at $99.25)		2,481.25	
Total Securities Owned			$22,428.03
Total in Endowment Fund, December 31, 1958			$23,602.61

Bonds listed at redeemable value December 31, 1958
Stocks listed as of closing prices December 31, 1958

Respectfully submitted,
/s/ RALPH M. EDEBURN
Treasurer

Research Grant Committee

Harvey Fisher, chairman, reported by letter that since, through a misunderstanding, the Committee had felt that no funds were available, no grants were made in 1958.

At its June 11, 1959, meeting, the Council voted $100.00 from General Funds, if no other funds are available, for the Fuertes Research Grant for 1959, and $75.00 from General Funds to make up the $100.00 for 1958. The Council also voted that the Fuertes Research Grant be made permanent until rescinded.

Therefore, as reported by Dr. Fisher, the Committee is moving forward for 1959–1960.

Membership Committee

Howard F. Young, chairman, reported by letter that the names of 188 new members, enrolled since the 1958 meeting, are posted for inspection by the members, to be elected at the final business meeting. Seventeen of these are Life Memberships, and 15 are Sustaining. Recent downward trends in membership are apparently halted, with membership at present approximately 1485, compared with 1475 as in the last report. In addition, there are 202 institutional subscriptions to the *Bulletin*.

Library Committee

William A. Lunk, chairman, reported that:

During the 12 months just completed, the committee has been reorganized, following the resignation of H. Lewis Batts, Jr., as chairman, with the appointment of Dr. and Mrs. W. Powell Cottrille as additional members.

Through meetings and correspondence, a number of matters pertaining to policy and procedure have been clarified. The question of adjusting the stocks of back issues of *The Wilson Bulletin* has not, to the committee's knowledge, been satisfactorily resolved; sizable surpluses of certain issues are still on hand.

Of major concern has been the incorporation of the library of the late Josselyn Van Tyne. The gift of an additional 200 reprints, and 130 books and pamphlets, from this library, by Mrs. Van Tyne, constituted the largest single addition to the Society's holdings. All of the Van Tyne collection has been placed on permanent loan to the Society, and is available to W.O.S. members for use as an integral part of the Josselyn Van Tyne Memorial Library. Cataloguing of the entire collection is proceeding. In accordance with the name change of the library, all new material (from whatever source) is being marked to conform. The permanent memorial book plate is not yet ready.

A list of items from the Van Tyne collection which are considered surplus has been prepared. This has been circulated so far, successively, to six individuals to whom Mrs. Van Tyne had asked that preference be given, and to a few other persons. A number of items have been sold, and the proceeds (perhaps $100.00 in all) have been placed in the Library's New Book Fund. The list will be available for circulation at the Rockland annual meeting; and it will be further submitted to individuals and institutions to be selected, before other means are employed to dispose of the residue. The New Book Fund is constantly being employed to purchase works, not otherwise provided, which are felt to be desirable tools to have at the disposal of the membership. There is still a small balance, the exact amount of which will be shown on the Treasurer's report.

Routine library matters are being competently handled by Technical Aid Norman Ford (Bird Division, Museum of Zoology, University of Michigan) who thus devotes a substantial share of his time to W.O.S. business. The close relationship between the Society and the University of Michigan continues to work to mutual advantage, with the latter supplying much-needed housing, binding, care, and general maintenance facilities, while profiting from the additional wealth of source material.

The library continues regularly to receive 93 journals, 81 as exchanges and 12 by donation. In addition, 84 separate donations have been reported: 561 reprints, 156 books, 252 journals, 13 pamphlets, 7 newsletters, 7 translations, and 1 phonograph record. Approximately 50 out-of-town loans were made during the year, involving some 150 separate publications—and this in addition to extensive on-the-spot use of the library by individuals on campus or visiting.

The committee wishes to express appreciation for the continued interest of the members, but urges even wider support for our whole library program. Donations, requests, and constructive suggestions are all equally solicited.

Endowment Committee

Olin Sewall Pettingill, Jr., reported 23 new Life Members and 3 Patrons.

Temporary Committees

The President appointed the following temporary committees:

Auditing Committee
N. Bayard Green, Chairman
Robert P. Van Blaricom
Rachael Wilson

Nominating Committee
Maurice Brooks, Chairman
Fred T. Hall
Margaret M. Nice

Resolutions Committee
Andrew J. Berger, Chairman
William A. Dyer
Ralph S. Palmer

SECOND BUSINESS SESSION

The final business session was called to order at 3:05 p.m., Saturday, June 13.

Olin Sewall Pettingill, Jr., spoke briefly on Society finances, mentioning the difficulty in increasing the membership, the need for new members, and the need for gifts to endowment and research.

The applicants for membership whose names were posted during the meeting were elected to membership.

Report of the Auditing Committee

The committee reported by letter that they had examined the books and accounts of the Treasurer and found them to be in good order.

Report of the Resolutions Committee

WHEREAS The Wilson Ornithological Society is in session at its Fortieth Annual Meeting in Rockland, Maine,

BE IT RESOLVED that the Society express its appreciation to the Local Committee under the leadership of Christopher M. Packard and Wendell Hadlock for the excellent planning and efficient organization that have made this meeting so enjoyable and interesting to the people in attendance;

AND BE IT FURTHER RESOLVED that the Society express its thanks to the sponsoring organizations, the Portland Society of Natural History, the Farnsworth Museum, and the Maine Audubon Society, for making available such fine facilities in such a pleasant setting for this annual gathering;

AND BE IT FURTHER RESOLVED that the Society express its thanks to the United States Coast Guard, and to Lt. Com. R. L. Davis, Commanding Officer of the *Laurel*, and to her officers and crew, for their generous hospitality aboard ship;

AND BE IT FURTHER RESOLVED that the Society express its sincere thanks to Ralph M. Edeburn for his faithful and effective service as Treasurer of the Society;

AND BE IT FURTHER RESOLVED that the Society express its thanks to Keith L. Dixon for his untiring efforts in maintaining, during his term as Editor, the high standard of *The Wilson Bulletin*.

Election of Officers

The Nominating Committee proposed the following officers for the coming year: President, Lawrence H. Walkinshaw; First Vice-President, Harold F. Mayfield; Second Vice-President, Phillips B. Street; Secretary, Aaron M. Bagg; Treasurer, Merrill Wood; Elective Member of the Executive Council, Ralph M. Edeburn (term expiring 1962).

The report of the committee being accepted, and there being no nominations from the floor, the Secretary was instructed to cast a unanimous ballot for these nominees.

Papers Sessions

Friday, June 12

Banding Symposium arranged by James Baird, *What Is Banding Presently Contributing to Ornithology?* (papers 1 through 3)

1. Carl W. Helms, Hatheway School of Conservation Education, Lincoln, Massachusetts. *Energetics and Annual Cycle—What Can Banders Contribute?*, slides.
2. Charles E. Huntington, Bowdoin College, Brunswick, Maine. *A Banding Study of Leach's Petrel* (Oceanodroma leucorhoa), slides.
3. Hubert Kluijver, Institute for Ecological Research, Arnhem, Netherlands (on Fellowship with Massachusetts Audubon Society). *Habitat and Reproductive Rate in Great Tit* (Parus major), slides.
4. John S. Webb and David Kenneth Wetherbee, Patuxent Research Refuge, Laurel, Maryland. *Southeastern Breeding Range of* Molothrus ater, slides.
5. Aaron M. Bagg, Dover, Massachusetts. *Aberrant "Fee-bee" Song of Chickadees on the Island of Martha's Vineyard, Massachusetts.*

Migration Symposium arranged by Chandler S. Robbins, *Current Bird Migration Research* (papers 6 through 12)

6. Robert E. Richardson, Lincoln Laboratory, Massachusetts Institute of Technology. *Radar Observation of Birds in the Vicinity of Cape Cod*, movies and slides.
7. William H. Drury, Jr., Massachusetts Audubon Society. *Radar and Bird Migration.*
8. Ian C. T. Nisbet, Cambridge, Massachusetts. *Reversed Fall Migration on Atlantic Coastal Islands and Its Relation to Wind-drift*, slides.
9. David B. Wingate, Hamilton, Bermuda. *A Discussion of Recent Records of North American Birds Occurring in Bermuda during Migration.*

10. James Baird, Norman Bird Sanctuary, Middletown, Rhode Island. *An Analysis of the Fall Migration in 1958 through a Study of the Banding Records from Various Coastal Stations*, slides.
11. Robert J. Newman, Museum of Zoology, Louisiana State University. *Further Studies of the Hour-to-Hour Variation in Nocturnal Migration*, slides.
12. Helmut C. Mueller, University of Wisconsin, Madison. *Weather and Fall Hawk Migration at Cedar Grove, Wisconsin*, slides.

Saturday, June 13

Wood Warbler Symposium arranged by George M. Sutton, *A Survey of the Parulidae* (papers 13 through 19)

13. Kenneth C. Parkes, Carnegie Museum, Pittsburgh, Pennsylvania. *Remarks on Taxonomic Relationships among North American Parulidae.*
14. James Bond, Academy of Natural Sciences, Philadelphia, Pennsylvania. *Evolution and Speciation of West Indian Parulids.*
15. Eugene Eisenmann, American Museum of Natural History, New York City. *Evolution and Speciation of Middle and South American Parulids.*
16. Lawrence H. Walkinshaw, Battle Creek, Michigan. *Life History Studies and the Contribution These Have Made to an Understanding of the Parulidae.*
17. Stephen W. Eaton, St. Bonaventure University, St. Bonaventure, New York. *The Comparative Approach in Studies of the Parulidae.*
18. Harold F. Mayfield, Waterville, Ohio. *Why Is the Kirtland's Warbler So Rare?*
19. Val Nolan, Jr., University of Indiana, Bloomington. *Population Dynamics in the Prairie Warbler.*
20. Tudor Richards, Dublin, New Hampshire. *Some Recent Changes in the Bird Life of the Lake Umbagog Region of Northeastern New Hampshire*, slides.
21. Eleanor E. Dater, Ramsey, New Jersey. *Nesting Sites of Lawrence's Warbler* (Vermivora lawrencei).
22. Allen H. Morgan, Massachusetts Audubon Society. *A New Technique for Photographing Birds*, movies.
23. Walter R. Spofford, State University Medical College, Syracuse, New York. *Feeding Habits of Appalachian Golden Eagles*, movies.
24. Lawrence I. Grinnell, Laboratory of Ornithology, Cornell University, Ithaca, New York. *Tropical Birds of Queensland, Australia*, movies.

Attendance

Members and guests who registered totaled 302. Twenty-four states, the District of Columbia, and the Canadian Provinces of New Brunswick, Ontario, and Quebec were represented, as were The Netherlands and Kenya.

From **California**: 2—*Pasadena*, Dr. and Mrs. Robert L. Taylor.

From **Connecticut**: 11—*Fairfield*, Mr. and Mrs. Edward A. Beddall, Mrs. Roy Larsen; *Greenwich*, Mr. and Mrs. John C. Schmid; *Hartford*, Mr. and Mrs. G. Hapgood Parks; *New Haven*, Philip S. Humphrey; *Old Lyme*, Roger Tory Peterson; *West Hartford*, Mr. and Mrs. E. A. Bergstrom.

From **Florida**: 3—*Coconut Grove*, Wayne Short; *Fort Myers*, Mr. and Mrs. George C. Erskine.

From **Illinois**: 4—*Blue Island*, Karl E. Bartel; *Chicago*, Mrs. Amy G. Baldwin, Eleanor Hudgeon, Catharine Schaffer.

From **Indiana**: 7—*Bloomington*, Val Nolan, Jr.; *Connersville*, Miss Edna Banta; *Mishawaka*, Mr. and Mrs. John W. Conboy; *Muncie*, Miss Ellen Heine, Mr. and Mrs. Harold A. Zimmerman.

From **Iowa**: 3—*Cedar Rapids*, Esther Pieters, Pauline Wershofen; *Davenport*, Peter Petersen, Jr.

From **Kansas**: 3—*Wichita*, Mr. and Mrs. Albert W. Briggs, Margaret Briggs.

From **Kentucky**: 6—*Louisville*, Fred Hunt, Eleanor Lovell, Mr. and Mrs. Harvey B. Lovell, Mr. and Mrs. Frederick W. Stamm.

From **Maine**: 82—*Augusta*, Dr. and Mrs. A. E. Brower, Mrs. A. C. Sturgis; *Bangor*, Mr. and Mrs. P. T. Coolidge; *Brewer*, Miss Hope Robinson; *Brunswick*, Charles G. Chase, Dr. and Mrs. Alfred O. Gross, Dr. and Mrs. Charles E. Huntington, Christopher Livesay, Daniel McKinley, Mr. and Mrs. Christopher M. Packard, Mr. and Mrs. F. Burton Whitman, Harry R. Tyler; *Camden*, George W. Perry; *Cape Elizabeth*, Mr. and Mrs. William P. Adams; *Cushing*, Mrs. Guy Brackett, Mr. and Mrs. Andrew Wyeth; *Damariscotta*, Dr. and Mrs. H. Benjamin Duce; *Hallowell*, Edward J. Baker; *Harrison*, Gen. and Mrs. Frank E. Lowe; *Kents Hill*, Mr. and Mrs. W. R. DeGarmo, Betsy Thamarus; *Lisbon*, Douglass H. Morse; *Mount Desert*, Mr. and Mrs. Robert Patterson; *North Edgecomb*, Mrs. Whiting Washington; *Orono*, Howard L. Mendall, Richard Zusi; *Portland*, Mrs. James Barlow, Mr. and Mrs. Edward F. Dana, Mr. and Mrs. Halsey Davis, Mr. and Mrs. Dan E. Edgerton, Charles B. Fobes, Mr. and Mrs. John H. Hyde, Mrs. Walter P. Reeves, Miss Belva L. Wilson; *Rockland*, Charles W. Cross, Mr. and Mrs. Charles Grant, Mr. and Mrs. Wendell Hadlock, Dr. and Mrs. Gilmore W. Soule, Miss Mary Wasgatt; *Rockport*, Mrs. Howard Apollonio, Miss Louisa D. Clark; *South Portland*, Mrs. Joseph B. Drummond, Mrs. Gladys D. Higgins, Mrs. Frank A. Kittredge; *South Thomaston*, Col. and Mrs. Mains; *Springvale*, Capt. and Mrs. Albert L. Prosser; *Stonington*, Mrs. Margaret Hundley; *Tenants Harbor*, Mr. and Mrs. William S. Cook, Mr. and Mrs. Paul E. Hannemann, Robert Fulton Logan, Philip W. Smith; *Thomaston*, Miss Hilda George, Mrs. Charlotte Gray, Miss Clara Spear; *Warren*, Mrs. Edith Wilder; *Wayne*, Mary Pettingill, Dr. and Mrs. Olin S. Pettingill, Jr.; *Wiscasset*, Mrs. D. B. Soule.

From **Maryland**: 6—Andrews Reese, Mrs. Sydney Reese; *Laurel*, Chandler S. Robbins; *Owings Mills*, Mrs. Elmer Worthley; *Takoma Park*, Mr. and Mrs. W. Bryant Tyrrell.

From **Massachusetts**: 39—*Amherst*, David K. Wetherbee; *Ashland*, Mr. and Mrs. James R. Warren; *Auburn*, Norman E. Holgersen; *Boston*, Allen H. Morgan; *Boxford*, Stuart K. Harris; *Brookline*, Henry T. Wiggin; *Cambridge*, Mrs. G. W. Cottrell, Jr., Dr. and Mrs. Ernst Mayr, I. C. T. Nisbet, Raymond A. Paynter, Jr., Mr. and Mrs. Wendell Taber; *Concord*, Peter R. Mott; *Dover*, Mr. and Mrs. Aaron M. Bagg, Theodore Chase; *Franklin*, John G. Minot; *Gloucester*, Mrs. Chandler Robbins II; *Hubbardston*, Mr. and Mrs. Lawrence B. Chapman, Mr. and Mrs. Gordon H. Smith; *Lexington*, Dr. and Mrs. Robert E. Richardson; *Marshfield Hills*, Joseph A. Hagar; *Medford*, Prof. and Mrs. Chester Littlefield, Ellen Louise Littlefield; *Newburyport*, Mrs. Clara DeWindt; *Salem*, Dorothy E. Snyder; *Sherborn*, Richard T. Darby; *South Lincoln*, Miss Virginia Armstrong, William H. Drury, Jr., Carl W. Helms; *Waban*, Mrs. W. E. Garrey; *Ware*, Mr. and Mrs. John H. Conkey.

From **Michigan**: 22—*Alma*, David Eyer, Jerry Eyer, Dr. and Mrs. Lester E. Eyer, Phyllis Eyer; *Ann Arbor*, Dr. and Mrs. Andrew J. Berger, M. Carol Branch, Mrs. Ralph M. Branch, Mrs. Reuben Kahn, Haven H. Spencer; *Battle Creek*, Dr. and Mrs. Lawrence H. Walkinshaw; *Grayling*, Mr. and Mrs. Fenn M. Holden; *Kalamazoo*, Dr. and Mrs. H. Lewis Batts, Jr., Miss Monica Ann Evans, Mrs. Donald

Stowe; *Marquette*, Mrs. Mary Spear Ross; *Union City*, Mr. and Mrs. William A. Dyer.

From **Minnesota**: 1—*Duluth*, Pershing B. Hofslund.

From **New Hampshire**: 7—*Dublin*, Mr. and Mrs. Tudor Richards; *Greenville*, Mrs. Bertram Wellman; *Manchester*, Mrs. Robert P. Book; *New Hampton*, Mr. and Mrs. Richard C. Hebert, Robert W. Smart.

From **New Jersey**: 17—*Bound Brook*, Bertram G. Murray, Jr.; *Bridgeton*, Herbert H. Mills; *Clifton*, Joseph R. Jehl, Jr.; *Mountainside*, Mr. and Mrs. Albert Schnitzer; *Mount Holly*, Francis Harper; *New Brunswick*, Mrs. Charles A. Reed, Jeff Swinebroad; *Orange*, Mrs. William A. Wachenfeld; *Pompton Plains*, Mr. and Mrs. Frank P. Townsend; *Ramsey*, Mrs. John Y. Dater; *Spottswood*, Julian Dickerson, Mr. and Mrs. Stanley S. Dickerson; *Tenafly*, Mrs. Herbert E. Carnes; *Upper Montclair*, Charles W. Lincoln.

From **New York**: 29—*Albany*, Ralph S. Palmer, Mrs. Dayton Stoner; *Alleghany*, Dr. and Mrs. Stephen W. Eaton; *Babylon*, Mr. and Mrs. Don R. Eckelberry; *Buffalo*, Harold H. Axtell, Fred T. Hall, Edward L. Seeber; *Hornell*, Marjorie E. Groesbeck, Mr. and Mrs. William M. Groesbeck; *Ithaca*, Mr. and Mrs. Lawrence I. Grinnell, D. S. Welch; *New York City*, Mr. and Mrs. Henry Buba, Mr. and Mrs. Carl W. Buchheister, G. Carleton, Eugene Eisenmann, Dr. and Mrs. G. Stuart Keith; *Rochester*, Mr. and Mrs. Allan A. Klonick; *Sayville*, Vladimir N. Rimsky-Korsakoff; *Scarsdale*, Henry H. Collins; *Syracuse*, Walter R. Spofford; *Waterloo*, Jason A. Walker.

From **Ohio**: 15—*Ashtabula*, Howard E. Blakeslee; *Cleveland*, Mr. and Mrs. William A. Klamm, Mildred Stewart; *Columbus*, Donald J. Borror; *Delaware*, Carolyn Sue Stull, Elizabeth Ann Stull, Mr. and Mrs. William D. Stull; *East Cleveland*, Vera Carrothers; *Painesville*, Mrs. Robert V. D. Booth; *Steubenville*, Earl W. Farmer; *Waterville*, Harold F. Mayfield; *Youngstown*, Dr. and Mrs. Fred H. Glenny.

From **Oklahoma**: 5—*Muskogee*, Mr. and Mrs. James L. Norman; *Norman*, Robert D. Burns, George M. Sutton; *Oklahoma City*, Robert H. Furman.

From **Pennsylvania**: 14—*Allentown*, John E. Trainer; *Butler*, Dr. and Mrs. Frank W. Preston; *Chester Springs*, Mr. and Mrs. Phillips B. Street; *Ogden*, Miss Harriet E. Worrell; *Philadelphia*, James Bond, Joseph M. Cadbury, C. Chandler Ross; *Pittsburgh*, Dr. and Mrs. Kenneth C. Parkes; *University Park*, Carl Frings, Dr. and Mrs. Hubert Frings.

From **Rhode Island**: 1—*Middletown*, James Baird.

From **West Virginia**: 2—*Huntington*, Dr. and Mrs. Ralph M. Edeburn.

From **Wisconsin**: 2—*Madison*, Mr. and Mrs. Helmut C. Mueller.

From **Vermont**: 3—*Londonderry*, Mr. and Mrs. James R. Downs; *Windsor*, Mrs. W. Cary Nicholas.

From **Virginia**: 2—*Oakton*, Dr. and Mrs. Ira N. Gabrielson.

From the **District of Columbia**: 3—Mr. and Mrs. Rudyerd Boulton, James Bruce.

From **New Brunswick**: 1—*Saint John*, W. Austin Squires.

From **Ontario**: 3—*Pickering*, Dr. and Mrs. J. Murray Speirs; *Swastika*, Fred Helleiner.

From the **Province of Quebec**: 7—*Hudson*, Mrs. G. A. Golden, Mrs. R. W. Wright; *Lachine*, A. R. Lepingwell; *Melbourne*, Mr. and Mrs. Lewis M. Terrill; *St. Anne de Bellevie*, Miss P. C. Abbott, Miss Ruth S. Abbott.

From **The Netherlands**: 1—*Arnhem*, Hubert N. Kluijver.

From **Kenya**: 1—Myles North.

This issue of *The Wilson Bulletin* was published on September 24, 1959.

EDITOR OF THE WILSON BULLETIN

H. LEWIS BATTS, JR.
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Kalamazoo College
Kalamazoo, Michigan

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SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the "suspended list." Postage is used in notifying the printer of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated in the mailing list and there is a printer's charge for this service. The *Bulletin* will become larger if members will make a point of paying their dues promptly.

NOTICE OF CHANGE OF ADDRESS

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Merrill Wood, Dept. of Zoology and Entomology, Frear Laboratory, Pennsylvania State University, University Park, Pennsylvania. He will notify the printer and editor.

NEEDS OF THE WILSON ORNITHOLOGICAL SOCIETY

(See committee reports inside.)

More Members—We need to increase our number to at least 2000. We could do this with only a little effort through selective solicitation by our approximately 1500 current members, each one of whom undoubtedly knows someone willing to join the Society for mutual benefit. A larger membership would enable us to increase the size of the *Bulletin*.

Larger Funds—

Endowment: Life Memberships ($100) and Patronships ($500 minimum) are our chief sources for this fund.

Research: The Society's Fuertes Research Grant, to encourage ornithological research work by amateur and professional, was not made last year because of a lack of money in that fund. In order to make a grant for this year, money has to be taken from the General Fund of the Society.

Library: The Library Book Fund enables the Library Committee to keep the holdings up to date and to fill gaps in the collection.

Contributions to any one or all of the above three funds would be most welcome. Checks, payable to the Wilson Ornithological Society, should be sent directly to the Treasurer with accompanying instructions as to which funds the contributions are being made.